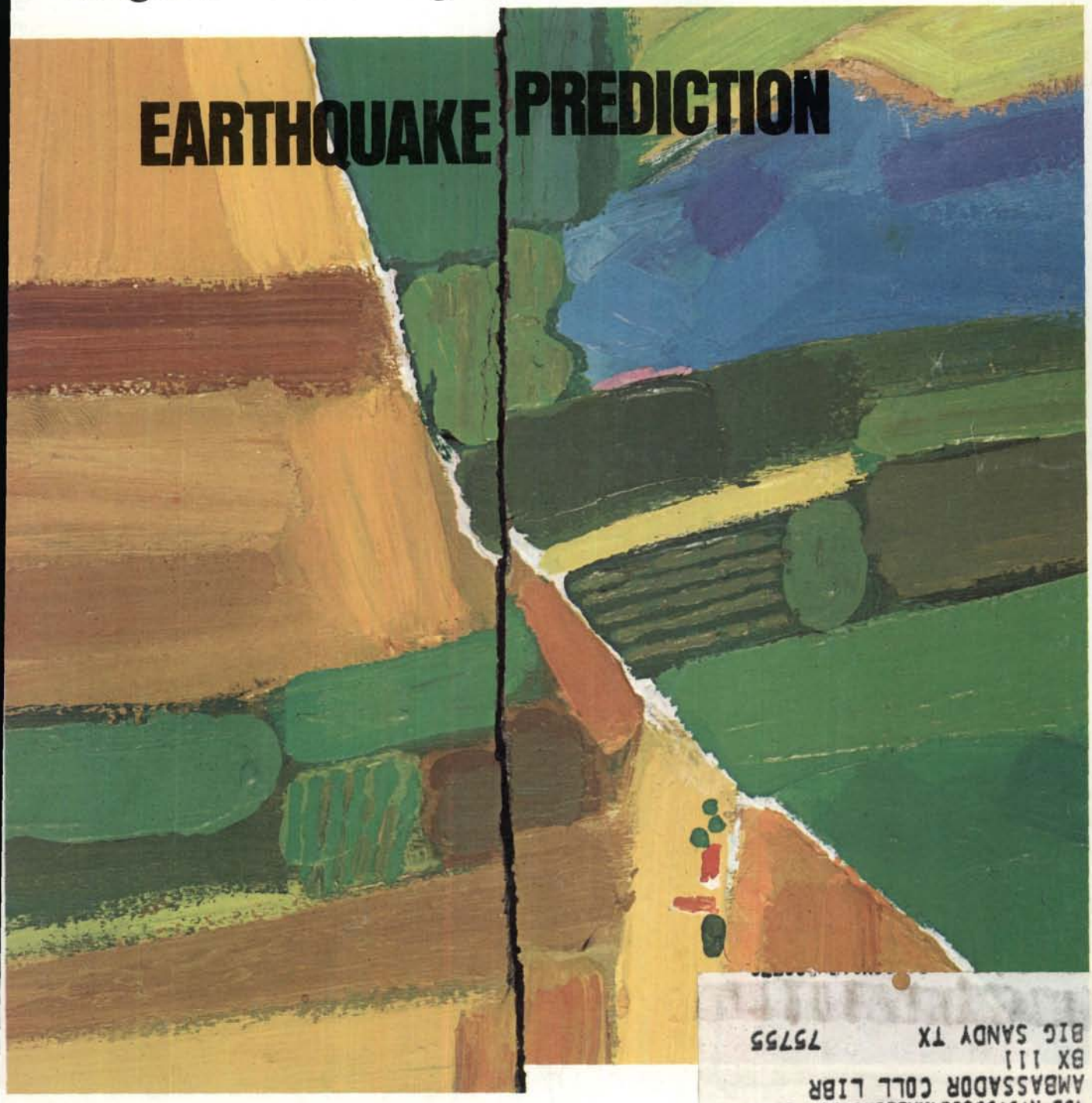
EBRUARY 1973

ONE DOLLAR

Saturday Review of THE SCIENCES

Jane Goodall's Chimps Sickle-Cell Dilemma

Magnets The Swing to "Practical" Science Diversity



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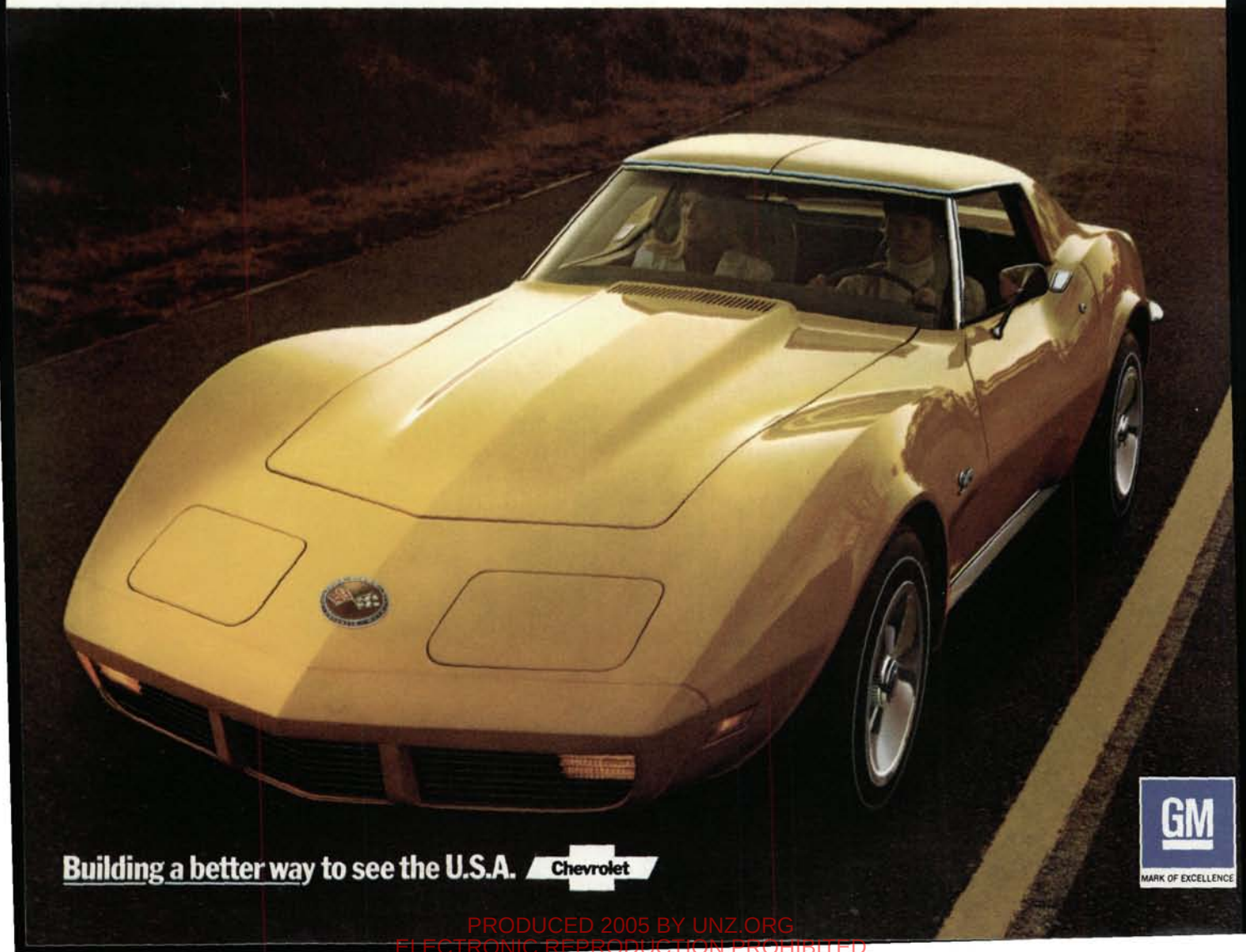

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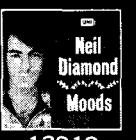

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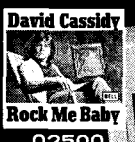

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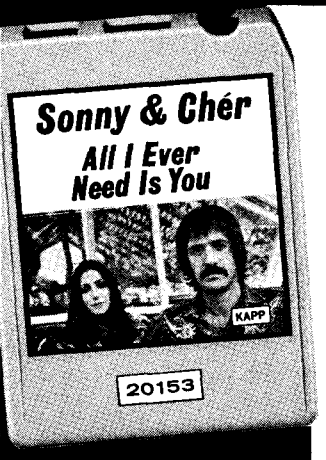

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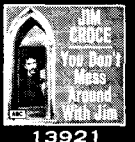

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Saturday Review of
THE SCIENCES

JANUARY 27, 1973 VOLUME I, NUMBER

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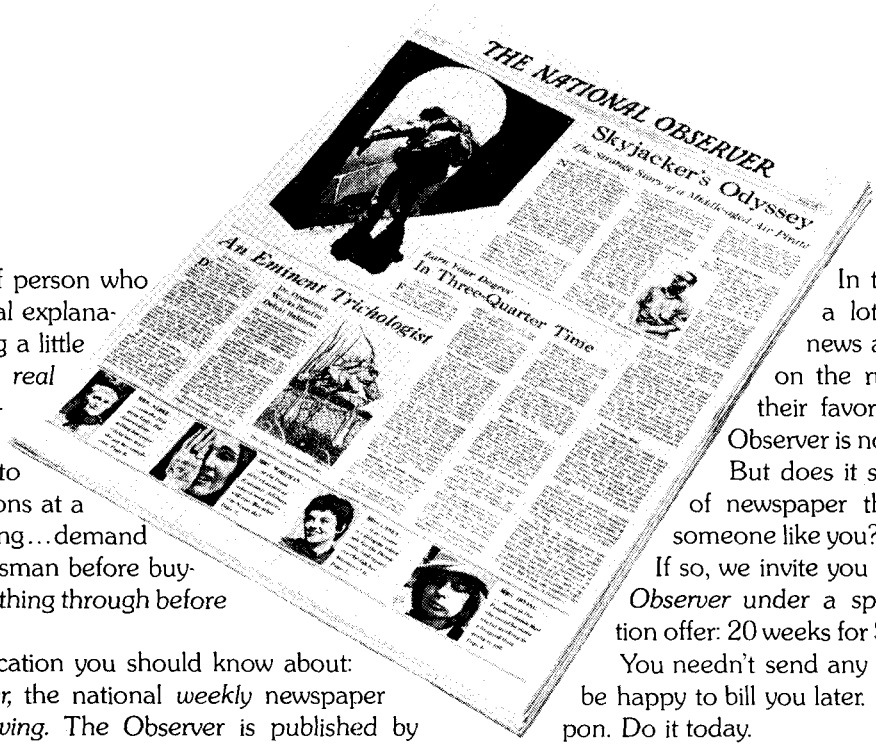

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INSIDE *SR*

During the past few weeks earthquakes have been prominent in the news. Luckily, the major quake predicted to rock San Francisco on January 4 by the mysterious and controversial geophysicist Reuben Greenspan did not materialize. A very real quake, however, did take the city of Managua, Nicaragua, by devastating surprise. This month's issue of *SR of The Sciences* leads off with an article by senior editor **Alan Anderson** on the efforts of California seismologists to predict and control quakes. Anderson, author of *The Drifting Continents*, toured California's earthquake country for this article, measuring creep in the Coyote Hills with a laser, walking through gloomy tunnels bugged with tiltmeters, and tracing the Hayward fault—under freeways, overpasses, churches, and housing developments.

Tabitha Powledge's article on sickle-cell anemia grew out of her work on genetic-screening legislation at the Institute for Society, Ethics and the Life Sciences in Hastings-on-Hudson, New York, where she is a research associate. Increasingly appalled at the rapid proliferation of spurious sickle-cell screening laws, Powledge told *The Sciences* that these mindless attempts at do-goodery seldom help to alleviate the real problems. A former English major, Powledge is currently pursuing a doctorate in physical anthropology.

For **Charlotte Beyers**, the profile of Jane Goodall in this issue marks the culmination of a year of research and writing about primates. As a research associate in the Department of Psychiatry at Stanford Medical Center, Beyers edited much of the recent work done at the Gombe Stream Research Center, where Goodall and others have spent years observing chimps in their natural habitat. Beyers recently left Stanford to devote full time to writing. She is now collaborating with a child psychiatrist on a book on learning disorders.

W. M. Schwarz, author of "Stalking the Mysterious Monopole," insists that he is, first of all, a teacher. However, he has vigorously participated in the search for the elusive magnetic monopole, a search that has taken scientists from the peaks of the Adirondack Mountains to the depths of the ocean. The author of a textbook on intermediate electromagnetic theory, Dr. Schwarz has been at Union College since 1946.

Bruce Wallace's thoughtful essay on the meaning of being human is a sequel to a lecture on Genetic Engineering and the Quality of Life that he delivered at the University of North Carolina. A professor of genetics at Cornell University, Dr. Wallace is also the author of *Essays in Social Biology*, a three-volume work that presents "useful" biology to the college student. Dr. Wallace's entrance into what he terms "biosociology"—the study of the contributions biology can make to society—was influenced by student demands for relevance in scientific education and by his notion that college biology should be more than a continuation of the biology taught in high schools.

Appearing Up Front in this issue of *The Sciences* are **Mark Bloom**, former science editor of the New York *Daily News*, who is now a New York–based freelance writer; **Barnard Collier**, a frequent contributor to *Saturday Review* whose specialty is Washington, D.C.; **Douglas B. Gasner**, a senior editor of *The Sciences*; and **Brian Vachon**, a former contributing editor of *SR* who is now managing editor of *Vermont Life*.

With this issue we introduce reviews of our field that will appear monthly in *The Sciences*. These regular features will cover science in all its facets: life sciences, social sciences, physical sciences, health and medicine, and technology. This month's departments were written by the staff, with the exception of "Eden and Evolution" for which we thank **Ron Moskowitz**, education correspondent for the *San Francisco Chronicle*. □

Anderson *Powledge* *Beyers* *Schwarz* *Wallace*

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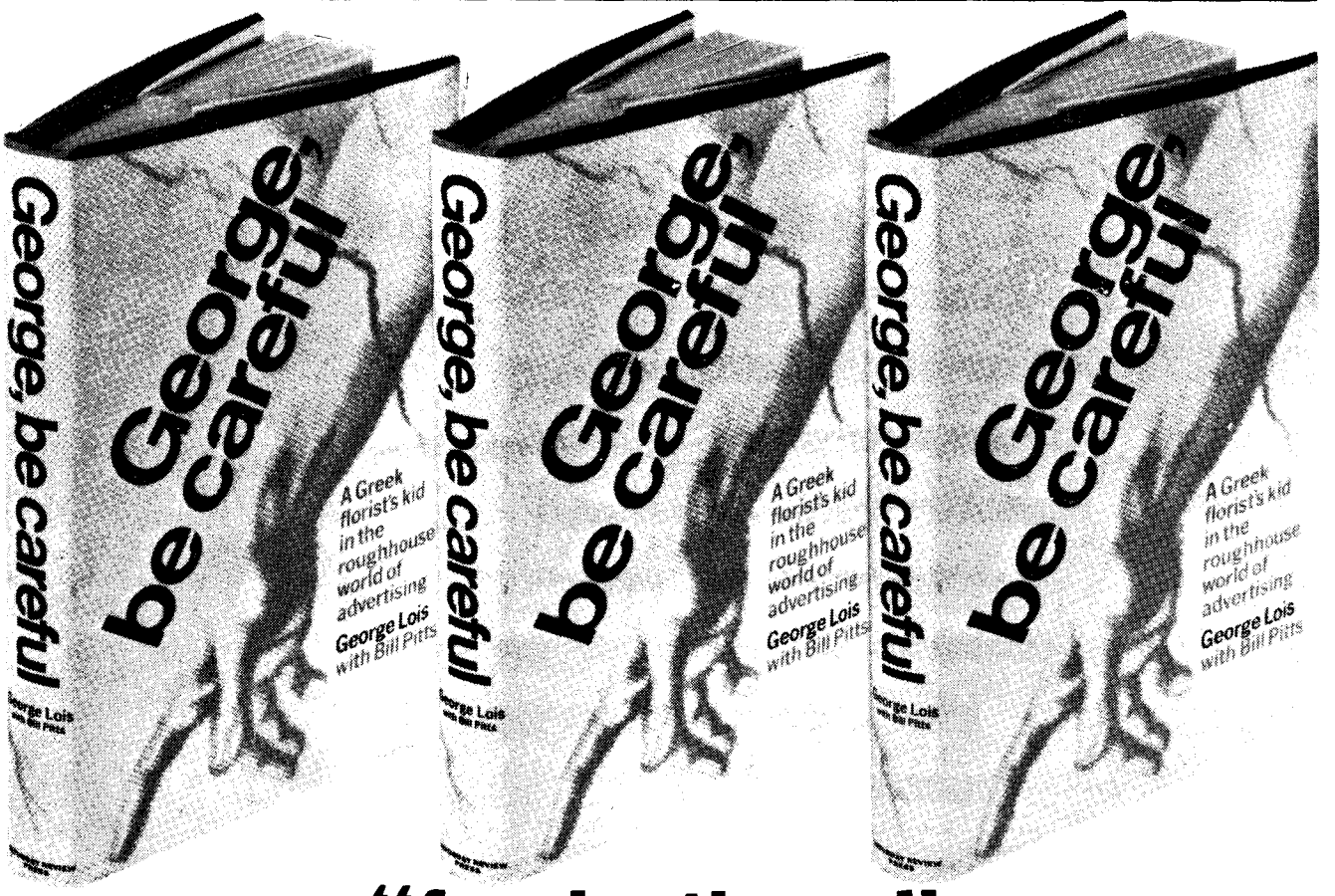
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with Bill Pitts

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A Moonwork Orange

BY MARK BLOOM

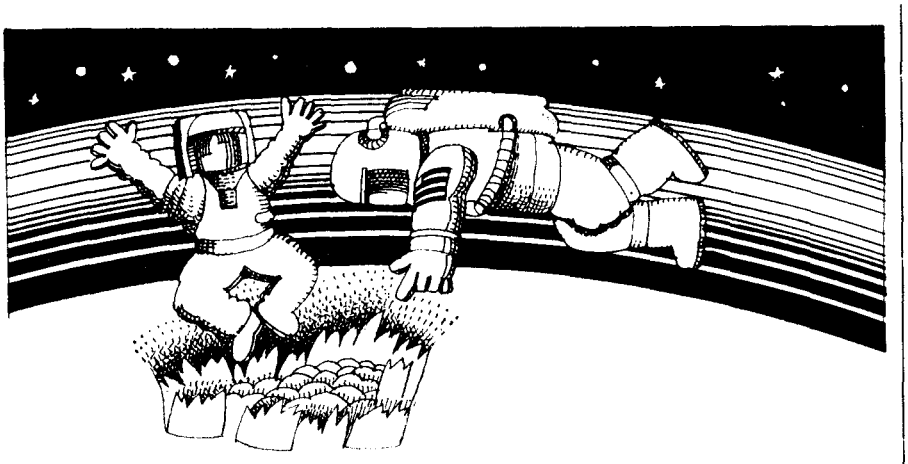
"There is orange soil . . . it's all over . . . it's orange . . . sure is . . . crazy, orange . . . I didn't think there would be orange soil on the moon."

The excited voice of thirty-seven-year-old geologist-astronaut Harrison (Jack) Schmitt crackled across a quarter of a million miles of space as he and his crewmate, Eugene Cernan, stared aghast at what they slowly realized was one of the major finds in lunar geology. They were well into the second of their three exploration periods when Schmitt's voice began to rise. Rising at the same time were expectations that the Apollo 17 mission would now provide a dramatic conclusion to an unprecedented technological tour de force—and perhaps even vindicate those who defended its scientific achievements.

There has always been something of a paradox surrounding the role of the astronaut on the lunar surface. The space agency has defended the necessity for man to be there by pointing out that he, unlike a rock-collecting machine, can adjust to the unexpected. At the same time, his stay on the moon is so limited and his exploration schedule so rigidly planned that when he is confronted by the unexpected, he is rarely able to give it his full attention.

When Jack Schmitt found the unexpected in the form of orange-and-red soil, he knew immediately that he faced a rare opportunity. Unlike the astronauts who had sampled the lunar surface before him, Schmitt was a professional geologist, uniquely equipped to react to such a turn of events as orange soil. But, even so, his strict training in the astronaut corps and the relentless pressure of the "time line" prevented a thorough study of Shorty Crater, where the rust-colored material lay.

The two astronauts immediately began to sample the area, racing time. Other geologists on the ground in Mission Control helped by telling the flight director that the orange soil should take precedence over everything else. A scant twenty-five minutes later, however, due to inflexible mission-safety rules, Cernan and Schmitt had to leave their find, despite the intense excitement felt by them and by everyone in Houston. Had the astronauts been robots, they could have sampled Shorty for hours or even days; on the other hand, robots would likely never have discovered the orange stuff in the first place.



"I didn't have time to really think at that station," said Schmitt to Mission Control as they headed off. "If I hadn't seen that [orange] alteration and all I'd seen was a fractured block on the rim, which looked like the stuff on the bottom, I might have said it [Shorty] was just another impact. But having all the color changes, I think we might have to consider that it could be a volcanic vent. I'm not sure how we prove it. We didn't have time to prove it."

"We noticed," said Mission Control. "I guess that's the breaks of the game sometimes."

Already, scientists are predicting that the orange material will extend by some two billion years the moon's known "internal lifetime" of 4.6 billion years. The soil may show that the moon, instead of cooling steadily during most of its existence, was still seething only a billion years ago, if not later.

"The discovery of bright orange and red materials at the crater Shorty lends credence to previous suggestions that Shorty and some other nearby dark, sharp-rimmed craters may be relatively young volcanic features," said a U.S. Geological Survey preliminary report. "Such a discovery would result in a major revision of current thermal models for the moon."

Thus, the last gasp of Apollo may also have revealed the last puff of the moon's volcanism—or is there even more recent activity to be discovered? Like the previous five manned landings on the lunar surface, Apollo 17 seems to have collected evidence indicating a complicated, dynamic moon, a far cry from the cold, pristine rock that many scientists had imagined before Apollo 11.

No more Apollos will land on the lunar surface. But with more than 850 pounds of the moon now on earth, scientists for decades will be busy theorizing and countertheorizing about the moon's history. Almost certainly, Russian cosmonauts will be trekking across the moon in the not-too-distant future, and unmanned probes will be sent by both countries. Like the moon, lunar science is not exactly dead; you just have to look hard for signs of life. □

'Tis a Hundred Years

BY BARNARD COLLIER

Apart from Galapagos turtles, great trees, and parrots, a century of time bears more relation to history than to life. So when I visited my first hundred-year-old man, Dr. Charles Greeley Abbot, and saw him drifting away in his easy chair with the reading lamp beside it dark, I said to myself, "I

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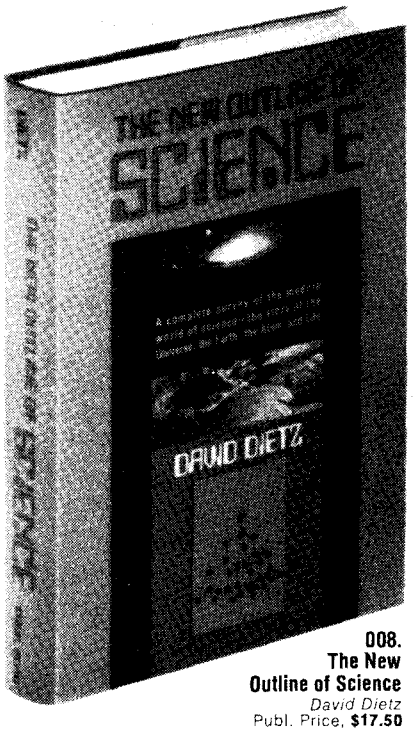

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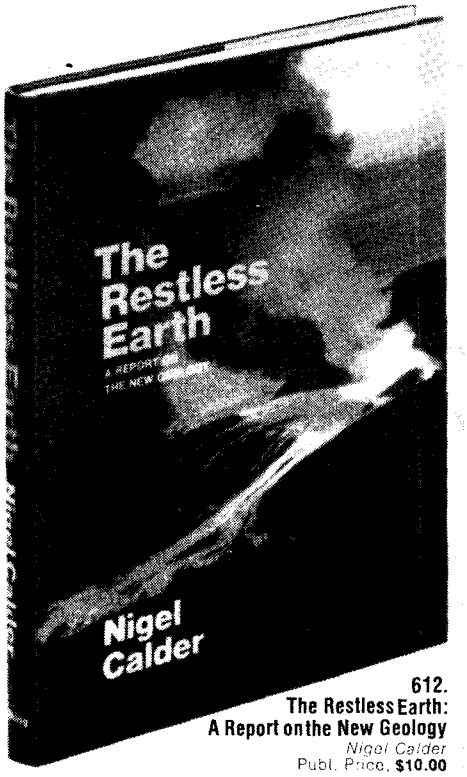

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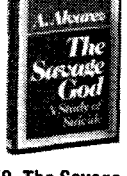

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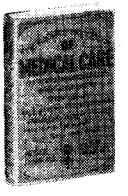

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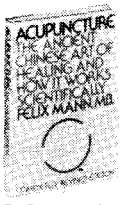

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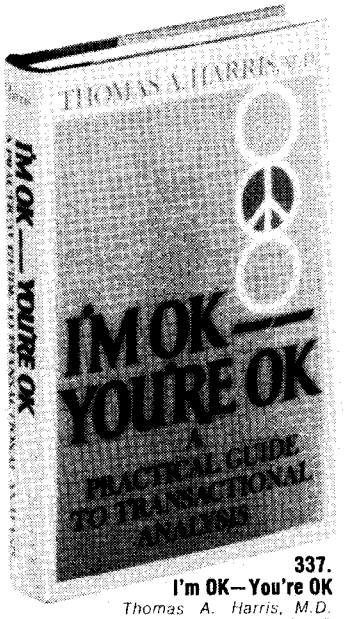

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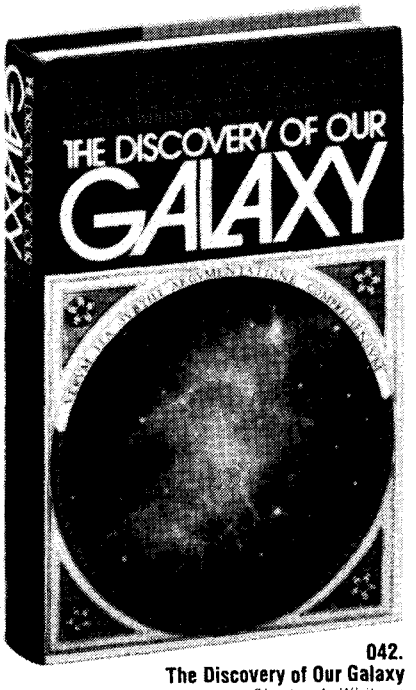

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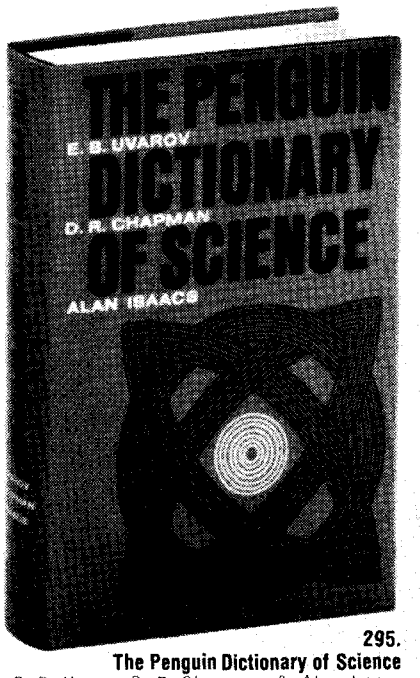

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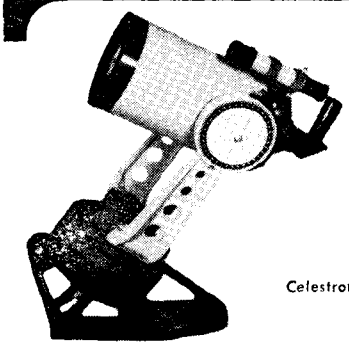

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wonder if it's worth having so much time?"

He told me that his legs are nearly gone, his back is weak, his hands shake so much it makes him mad as a hornet when he turns a page or writes down some idea. He can't smell anything, he can't hear without a hearing aid, he forgets some words entirely and forgets how to spell others (his wife, who is eighty-two, is forgetting how to spell, too, and they both wonder why that skill goes so soon), and his eyes work now in peculiar ways.

The Russians thought he was certainly dead five years ago, because his classic work with the scientist Samuel Pierpoint Langley (1834–1906) in the area of solar radiation, the infrared spectrum, and other astrophysical discoveries was published before 1900. And Dr. Abbot was already an old man when he retired as secretary of the Smithsonian Institution in 1944. Therefore, the Russian delegation to the Nomenclature Committee of the Astronomical Union proposed in 1967 that a crater on the far side of the moon be named for Dr. Abbot. By rigid tradition the moon's craters are named only as posthumous honors, with the exception of those named after six live American astronauts and six live Russian cosmonauts. And now it seems that after delaying for more than five years, during which Dr. Abbot did not expire and thus make matters simpler, the Astronomical Union is supposed to meet next summer and will vote on whether or not the living Dr. Abbot should be so unprecedentedly honored in his lifetime for work not all *that* significant. Lord knows what the politics are, because the Russians withdrew his name when they found out the old man was still alive. Then it was put back in nomination again—by whom, no one is eager to say. But the Smithsonian people insist that the vote next summer ought to be "pro forma" even if Dr. Abbot is still around to get a kick out of it.

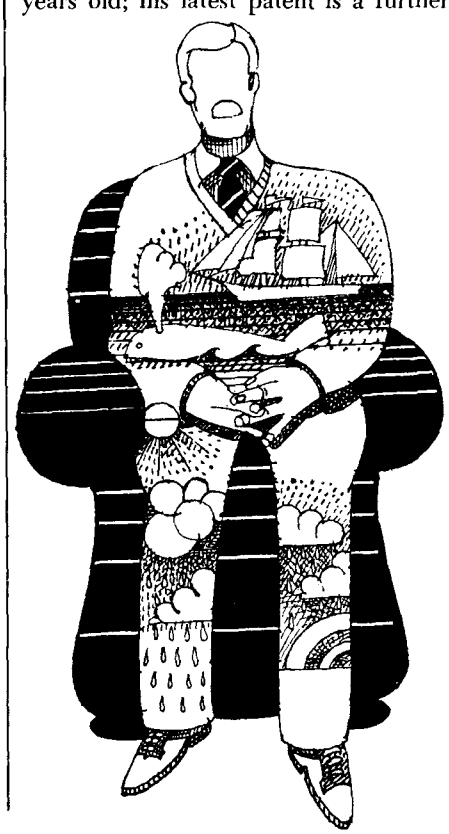
Meanwhile, the old man lives on in a comfortable, English-countryside brick house a few blocks away from the campus of the University of Maryland in Hyattsville, with a cool, shady yard and a small greenhouse outside the back windows.

His wife keeps house, and Dr. Abbot sits with his slippered feet propped up on a footstool, reading and dreaming. He takes pride in his appearance. His face is shaved (imagine running a razor over your face every morning when you have lived one hundred years), and his light gray summer suit and blue Paisley necktie are young and fresh looking. He has a big, white moustache clipped right at the corners of his mouth, and his hair is white. His eyes are dark blue and very unusual.

"My right eye drifts off to the right," he explains in a strong old man's thinning voice. "Therefore, when I see a tree or a house, while driving to church on Sunday morning, my eyes are focusing a yard apart instead of about six inches. I can enjoy seeing objects double and sometimes triple. It's very satisfactory."

Most people these days come to Dr. Abbot's house so that they can talk to him about one of his latest inventions. Some Indians even called him long distance from India to talk about them. Dr. Abbot answers his own telephone calls; he tells most people they should leave him alone to work, and he then abruptly hangs up. His wife, Virginia, may try to smooth things out, and he'll mutter, "Okay, you can come, but don't make me mad." If you apologize for taking the time of a man one hundred years old, he snaps, "I'm very jealous of my time."

Dr. Abbot's most recent invention is registered under U.S. Patent No. 3,376,165, and he received the patent last year when he was ninety-nine years old and, as far as anyone knows, the oldest person ever granted a United States patent. It is an apparatus of lenses for focusing the sun's rays into a black-box radiator wherein enough heat is produced, up to an estimated 3,000 degrees Kelvin, to run a turbine, which in turn will produce low-cost electricity with zero pollution. The idea for the basic apparatus (which he patented when he was ninety-six years old; his latest patent is a further



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modification) was revealed to him in a dream at two o'clock in the morning in July 1965. "The lawyers couldn't get the patent people to move then like they can now," he says, "so it took three years to get my idea patented. But my last patent took only three months, and I've had at least 500 letters from companies with an interest in buying it."

Now he's working on still another patent, which will modify and perfect the lens mechanism on his invention; and at the same time he is trying to dream up a way of converting the heat in the black box directly into electricity, instead of wasting energy by running a mechanical turbine to produce the electric current. He is very serious about the dreaming part. "Your old men shall dream dreams; your young men shall see visions," he says. The quotation is from the Book of Joel.

His mind is a cheerful museum of fascinating memories, much like the Smithsonian, which he visits every other Monday morning in order to collect and read his mail and watch young women. He is known as a collector of Marmaduke, the Great Dane, cartoons, a hobby that seems a little quaint for his taste. "I collect them," he explained, "because the secretary's secretary likes them and she likes us." So each visit he carries a packet of Marmaduke clippings with him.

Dr. Abbot can describe in acid detail how Samuel Langley's famous bolometer for measuring radiated heat at first traced spectrums from the sun that were so outrageously crude they ran off a three-foot-wide piece of graph paper. He tells how he devised a way of making the instrument hundreds of times more sensitive and useful, "with Langley taking all of the credit," he grumbles.

He recalls Madame Curie and Robert Goddard, the American rocket pioneer who was regarded as a crank by most of the Smithsonian people except for Dr. Abbot, who had faith in Goddard's work and squeezed enough money out of the tight Smithsonian budget to support Goddard's work. (Dr. Abbot a few years ago presented some friends with a phonograph record of his reminiscences of the Smithsonian budget battle, with curmudgeonly old "Uncle Joe" Cannon (1836–1926) of the House of Representatives on one side and Dr. Abbot singing sea chanteys from his childhood on the other.)

Dr. Abbot is convinced by nearly fifty years of intensive study and work that the world's general weather patterns are directly related to the fluctuations of solar radiation, with sunspots taken into consideration. If you press him a little (which I didn't), he has at hand an oatmeal carton, around which is wrapped twenty feet of graph paper filled with hand-penned graphs and records of the weather in St. Louis, Missouri, from 1854 until 1957. The graphs demonstrate how very close his predictions of St. Louis's weather, based on solar-radiation cycles, came to the real weather in St. Louis. Weathermen are skeptical about his work in their field, but Dr. Abbot says time will prove him correct, as it did Copernicus.

By now ninety minutes of time have been used, and Mrs. Abbot says to her husband, "I know you are enjoying it, because you haven't kicked him out, but your voice is going to go if you don't quit now."

Dr. Abbot shakes his head stubbornly, ignores her warning, and announces, "I'm going to sing you a song." And here is exactly what the one-hundred-year-old man sang, in a sure, clear voice suggestive of that of a very old American sailor singing nearly a century ago.

"'Tis a hundred years," said the bo'son bold,
"Since I was a boy at sea.
'Tis a hundred years, so I've been told,
And that's the truth," said he.
"And that's the truth," said he.

"We sailed a-way from Milford Bay,
The North Pole for to see;
And we found it too without much ado
And that's the truth," said he.
"And that's the truth," said he.

"We sailed and sailed, and one fair noon,
A great whale we espied.
So we took a rope and a long harpoon,
And stuck him in the starboard side.
Then away and away went the great big whale,
And away and away went we.
Made fast to his tail to the north we did sail,
And that's the truth," said he.

"When we came to the great North Star,
An iceberg we did see.
Said the captain, 'Now we have come thus far,
I'm not going back,' said he.
So we tickled the tail of the great big whale
With a tenpenny nail, did we.
And we sailed right through that iceberg blue,
And that's the truth," said he.

"And then the North Pole we did see,
And we anchored the whale astarn,
But he gave us a whack that sent us back,
Or I mightn't have been spinning this yarn.
So messmates all," said the bo'sun bold,
"If the North Pole you would see,
You've got to sail at the tail of a whale,
And that's the truth," said he.

"It's not a very good voice any more," snorted my hundred-year-old man, who was highly annoyed; but then he closed his eyes and drifted off to somewhere celestial in his easy chair. □

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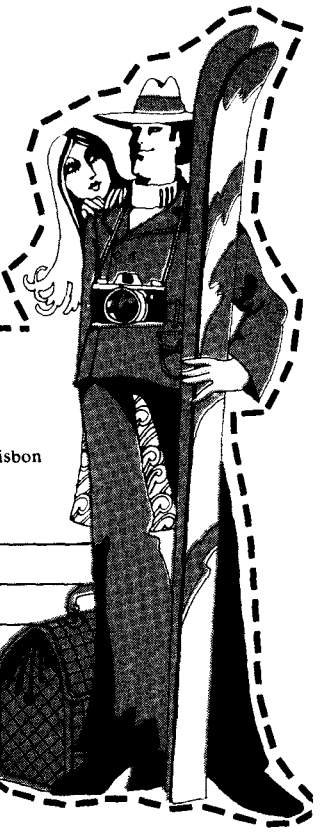

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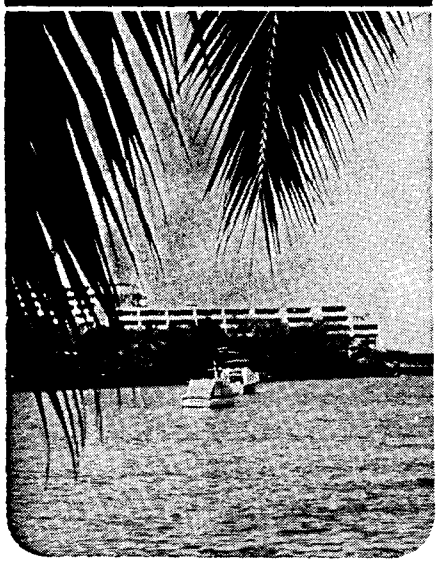

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BY BRIAN VACHON

A bird is an instrument working according to mathematical law, which instrument it is in the capacity of man to reproduce with all its movements.
—LEONARDO DA VINCI, 1505

The flying machine which will really fly might be evolved by the combined and continuous efforts of mathematicians and mechanics in from one to ten million years.
—EDITORIAL, *New York Times*, 1903

There are some people who simply won't take no for an answer from nature, and I guess I'm one of those people. I look at a bird and watch it in flight, and I'm determined to reproduce what that bird does mechanically.
—JAMES L. G. FITZ PATRICK, 1972

Leonardo was partially right. It is within man's capacity to build a device that can duplicate the movements of a bird. But to make it fly, or to translate that movement to human sinew and muscle is something else altogether. Leonardo failed because he completely overestimated man's strength and endurance when he invented his rope-and-pulley-operated flying machine. It should be added that Leonardo passed on the task of testing his invention to one of his subordinates.

The *New York Times* editorial was totally wrong, and that's something one doesn't very often have an opportunity to state categorically. The anonymous editorial writer was obviously annoyed at America's flight fanaticism at the turn of the twentieth century, when people were strapping makeshift wings to cars, donkeys, blimps, and bicycles. It had to be a source of some embarrassment to him when, several months later, Orville and Wilbur Wright managed to raise a man-carrying machine a few feet into the air and keep it flying for nearly a minute.

Nevertheless, man still has not learned to fly like a bird. We've learned to fly, all right. High in the stratosphere, grinding out the grisly business of automated warfare in B-52s. Ten abreast and $2 extra for the earphones on 747s. But never like a bird. No one has ever invented a machine that will leave the ground with virtually no take-off run, then glide and soar with flapping wings powered from within. And that brings us to James L. G. Fitz Patrick, the man who won't take no for an answer from nature.

For the last thirty-eight years Fitz Patrick—who is dean of Staten Island Community College—has been attempting to invent a machine that will fly like a bird. Now, at age sixty-six, with more than 200 discarded models and an estimated 27,000 hours of experimentation and observation behind him, Fitz Patrick is ready to test-fly his man-sized ornithopter, a six-foot-long, 320-pound craft with wings that can extend twenty feet or tuck in as close and neat as a seagull's. The machine has no tail or propeller, and its power plant is a one-horsepower gasoline engine that provides the drive for five single-stroke, compressed-air cylinders. They, in turn, provide flapping power to the wings—steel-cable and sail-cloth copies of the delicate and complex wings of a bird. In March—on St. Patrick's day, in fact—Fitz Patrick plans to haul his machine to a field on the college campus and take it aloft.

But what of it? The human flight obsession was reasonable when man was anchored to earth, but what justification is there now? What's the importance of a flapping machine if fixed-wing aircraft can soar higher, faster, and for longer distances than any bird ever created?

"The immediate practical application of a beating-wing aircraft is S.T.O.L.—short take-off and landing," Fitz Patrick says. "Modern aircraft are fine for long-distance flights, but they're useless in short hops. How are you going to get home tonight?" he asked me one evening as we were sitting in his comfortable living room, talking about his project.

"Drive down to the ferry, take it across, and then drive up the West Side highway," I said.

"Right!" Fitz Patrick said. "And if you're lucky enough to catch the ferry without a wait, it'll take you about an hour. With a maximum speed of forty miles per hour, an ornithopter could get you home in about fifteen minutes. Take off from the yard out front and land on your apartment roof."

"So could a helicopter," I challenged.

"But look at the tremendous amount of power a helicopter uses and the noise it makes and the pollution it creates. A helicopter with the same engine as the Cessna-172 I often fly can carry only half the load for half the range. They're just not that practical."

Practicality is what Fitz Patrick's personal philosophy is all about. Despite an ambition that would seem to put him in the company of some of history's loonier would-be birds, he is thoroughly pragmatic about what he hopes to achieve. He sees the ornithopter as a

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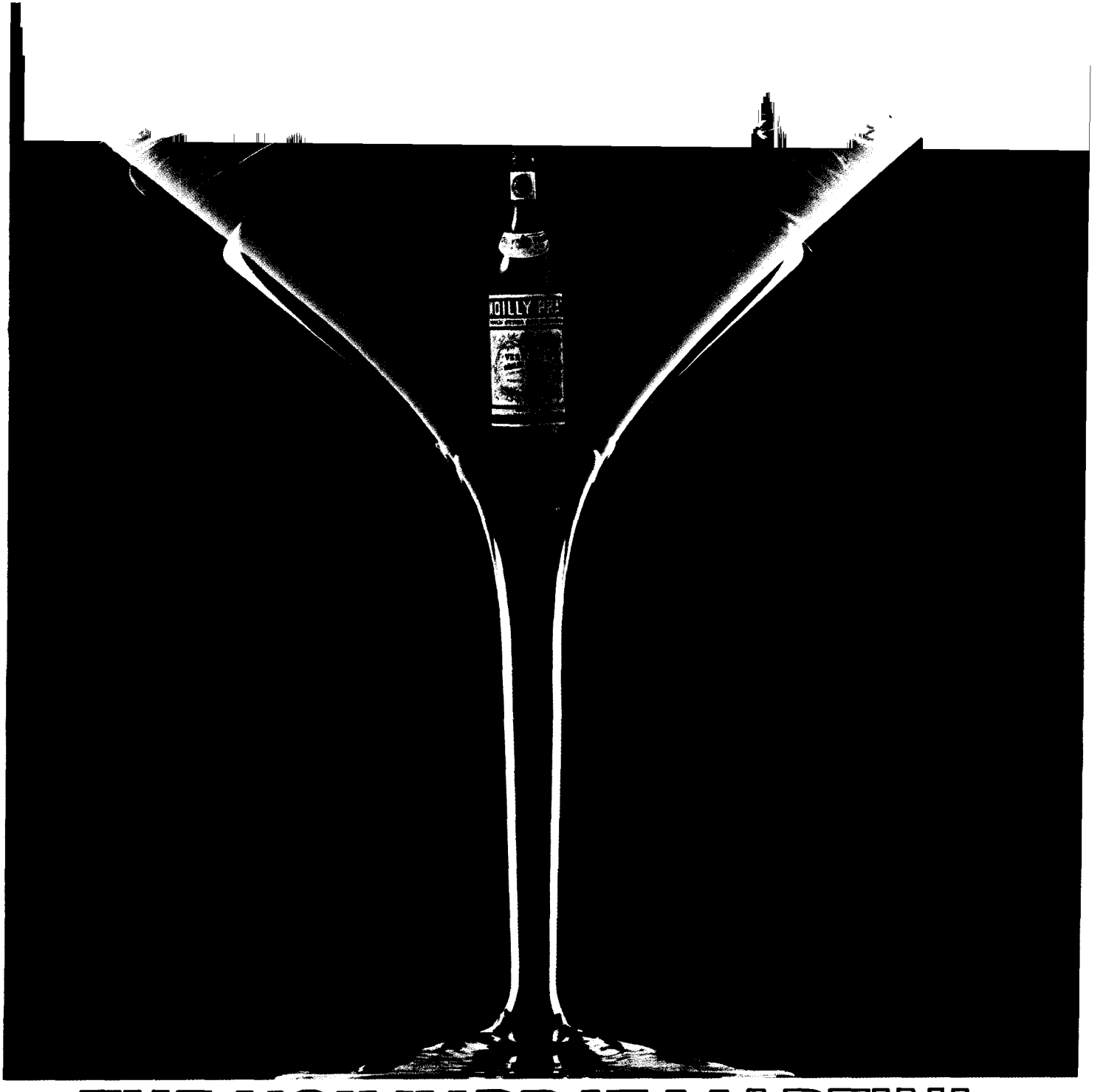

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al and practical solution to clogged ghways and befouled air, one that ould use less than half the fuel of a ane and be practically noiseless.

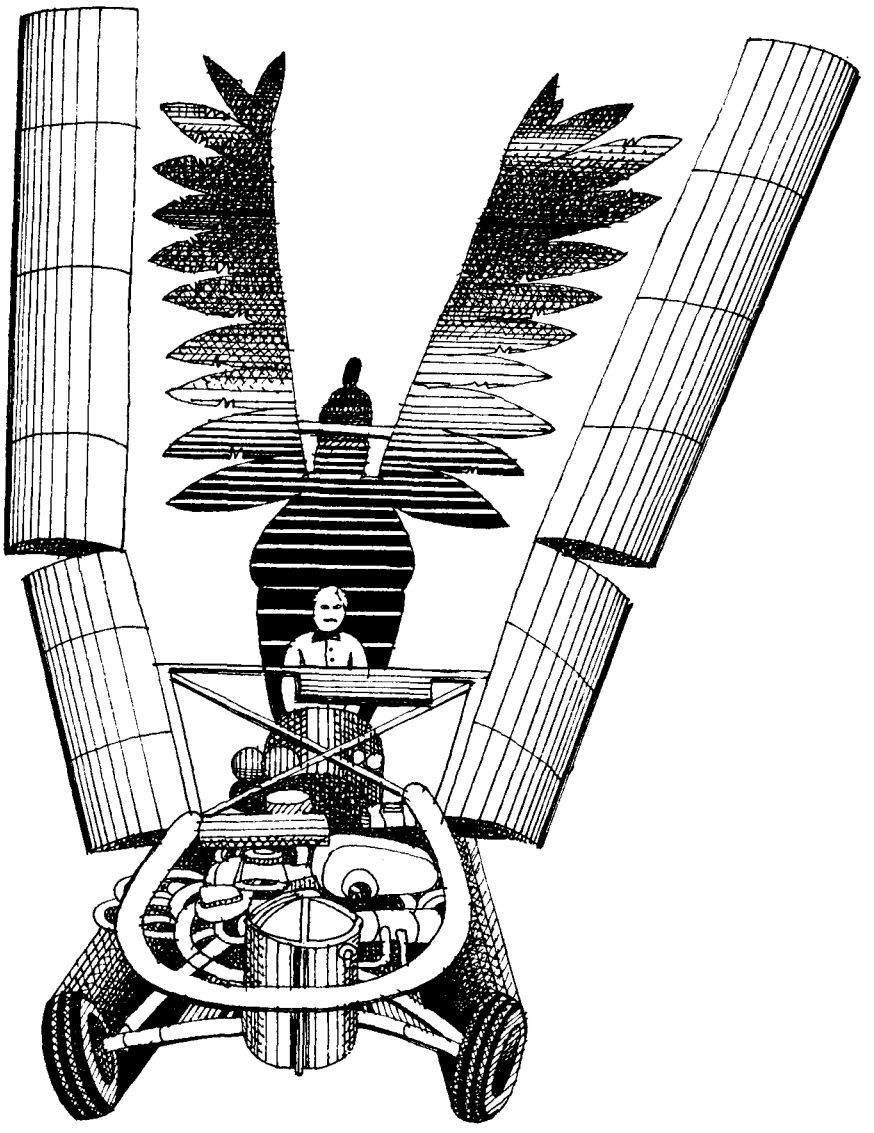
Although Fitz Patrick has degrees in ıysics and engineering, his knowledge aerodynamics is for the most part lf-taught. "I decided pretty early that) one would ever be able to fly very r using only their own power. Human ɔne structure and muscle arrangement ake the body very unsuitable for ings. Maybe someone with no legs ıd two hundred pounds of muscle in s stomach would have a chance. I ıve dim hopes for anybody else."

Despite the fact that the power for ght would have to come from some nd of engine, Fitz Patrick fixed his perimental attention on birds. It was ırly evidence of his practicality. "When began to think about the most ef-ient means of transportation, I asked yself, 'Why come up with a new eory when birds have been flying ef-rtlessly for 20 million years?' Some ople think that nature is a poor en-neer. I don't go along with that."

Fitz Patrick has collected almost erything printed about winged flight, ırresponded with a half-dozen orni-ıopter enthusiasts throughout the orld, and compiled a bibliography at lists some 2,000 articles and 500 ıtents for potential flapping-wing fly-g machines—none of which, to his ıowledge, has ever worked. "Never ıs so much been done with so little ccess," he says with a trace of relish. "I'd see a bird fly, and I'd make an ɔservation—about the tilt of the wing the rate of the beat. Then I'd sit ɔwn, think about it, and come up with hypothesis. I'd test that hypothesis ith a model wing, and invariably I'd ıd out that I had made an error some-here along the line. There was fail-e after failure, but I was refining, wering the area of ignorance."

Over the years Fitz Patrick's three-ory Staten Island home has evolved to a laboratory for his ornithopter oject. The boiler room was converted to a library and work area, another ction of the basement into a machine ıop. On the second story, next to the edroom, is a small room with a sink, ork table, and file cabinets, where ıore than three hundred birds have ɛen dissected.

The attic of the house contains a fteen-foot rotating arm on which Fitz atrick tests model wings at speeds up) thirty-five miles per hour. On the airs to the attic is a control panel om which he can regulate the speed nd tilt of the experimental flapping ings as the arm spins over his head. n the walls of the attic hang some of ıe more than three hundred "failures" —small wings that Fitz Patrick has as-



sembled and tested in his thirty-eight-year quest to build an ornithopter. So far all the tests have been made on scale models attached to the rotating arm. But soon the accumulated data from the models will be put to practical use as Fitz Patrick tests his full-scale bird, now roosting in his garage.

Since there have been 319 test models to date, Fitz Patrick has christened his bird simply "320." "It's pretty near ready to fly," he asserts, but despite this confidence Fitz Patrick is hedging all bets on the future with a single rationalization. "You have to remember," he cautions, "that in the two million or so years of human history, there has always been a preoccupation with flying. We tend to forget that thirty or forty years represents just a tiny niche in time. I don't look on my work with the ornithopter in terms of success or failure. It's just part of an ongoing fascination with flight."

Sure. But come St. Patrick's Day, when the dean of Staten Island Community College wheels his gangly tangle of cord and cloth onto a grassy patch of campus, climbs into the single seat, and revs up the tiny engine, will that practical rationale prevail? He insists he is but an insignificant part of the history of human flight. But on the day James L. G. Fitz Patrick tries to fly like a bird, he might just *make* history. And never mind his sly smile and wink. He'd like nothing more in the world. □

Bye Bye Birdie

BY DOUGLAS B. GASNER

A presidential inauguration is as well orchestrated as a moon launch or a Republican nominating convention. Even the birds—mostly starlings and house sparrows—are written into—or more accurately—*out of* the scrutinized script. I inadvertently was alerted to this fact in Washington the other pre-inauguration day by the distracting behavior of a crew of workmen.

Now, such sights are commonplace in town as the route from the Capitol

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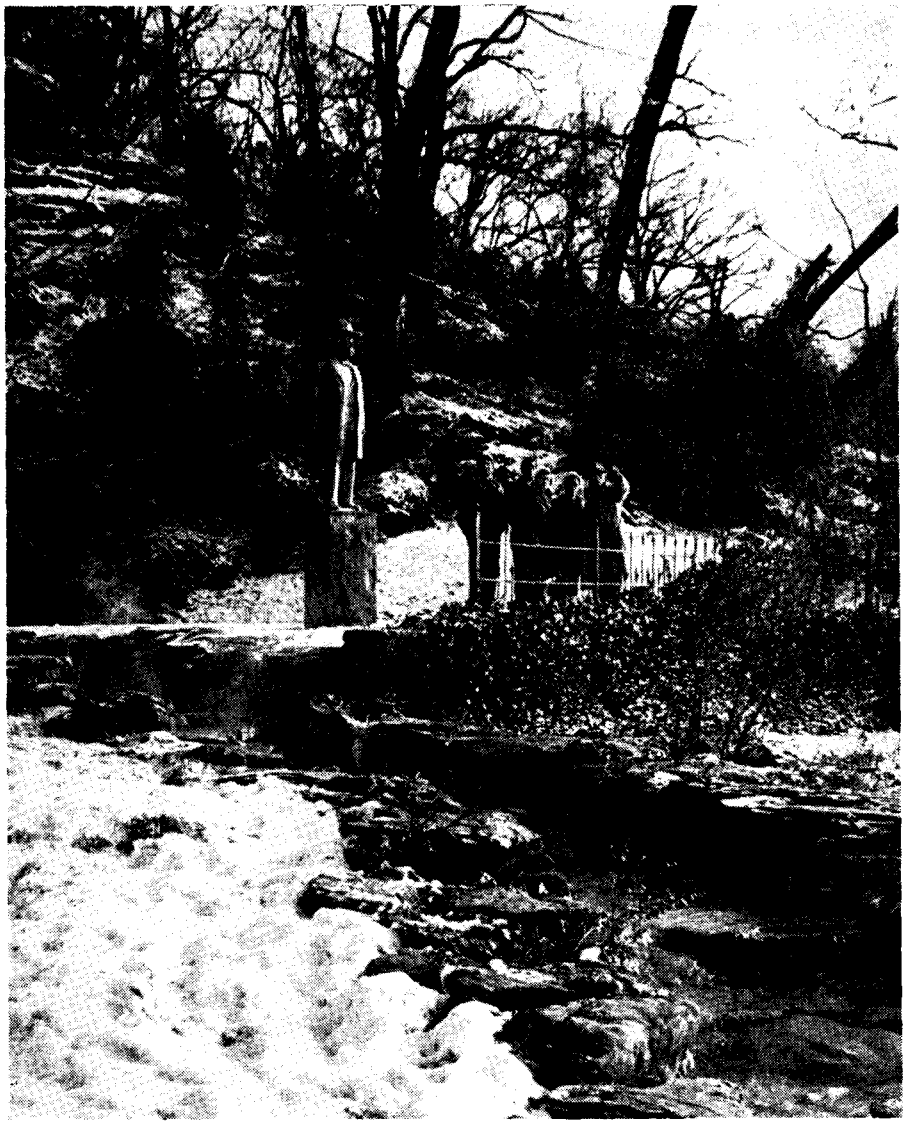

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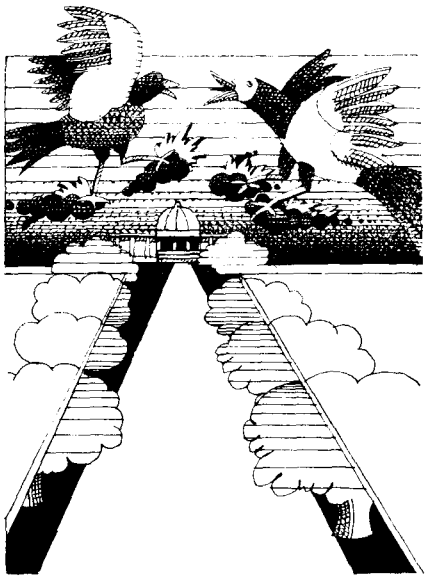

to the White House gets appropriatel decked out or, as the English sa "fluffed up" for the occasion. But th particular crew was spraying tre along Pennsylvania Avenue. Hardy i sects? Sap that runs with snow? So asked. It seems that the inaugural in presarios were plastic-coating elm magnolias, and whatever else provid a convenient landing limb for bir that happen to wander onto the set. drop from above, I was told, on s momentous an occasion as the inaug ration could do monstrous damage t the dignity of any notable onlooker.

The transparent stuff is indeed i sidious to birds, for, once applied, provides any hapless bird with a chem ical hotfoot. (The manufacturers pre fer to describe the effect as "a tinglin sensation.") The birdproofing—calle Roost No More—is the product of th National Bird Control Laboratories i Skokie, Illinois, headed by Joseph Fink Although the active ingredient is privi leged information, Mr. Fink insists tha it is harmless to the trees, nontoxic t the birds, and impervious to the ele ments. A single spraying conveniently renders trees bird-free for up to two years.

This year for $12,000 a droplet can opy of Roost No More quietly settle on eighty-eight trees lining the choices viewing spots. I was assured by Inaugu ral Committee staff member Paul Moore that any seat I choose from $2 to $5(along the parade route would be, shal we say, embarrassment-free. Says Moore: "We guarantee every customer a clean seat."

Science and technology are wonder- ful. I wonder whether they'll find a way to make the sun come out next time. □

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TRAVEL

The Best Trains in the World

BY DAVID BARTRUFF

The honorable and very popular custom of traveling by train is as much a Japanese institution as sipping sake at a cherry blossom festival, but of considerably more recent vintage. And no wonder: Japan operates one of the fastest trains in the world. If numbers carry any weight, the railroads of Japan certainly qualify as the world's most remarkable mass movers, transporting an incredible 10 billion passengers a year. This means that on the average every one of Nippon's 100 million citizens boards a train 100 times a year.

Actually, two out of every three passengers are commuters, mainly suburban white-collar workers who ride to work and back five or six days a week, 250 to 300 days a year. Indeed, commuting in Japan is done almost exclusively on the convenient electrified trains, whose coaches turn into sardine cans during the morning and evening rush hours. Cross-country journeys are made on super expresses with reserved seats.

No resident of even the most remote Japanese fishing village puts up with what the riders of the Long Island Railroad endure stoically. In Japan trains are expected to operate on time and on tight schedules—and to run fast.

Given Japan's dense population concentration in the urban centers, its railroads have the world's heaviest rush-hour jams. Although some Americans still refuse to believe that Japanese railways employ "pushers" at station platforms to help shove passengers aboard trains, the practice persists. On the seven major commuter lines serving Tokyo, the pushers pack in an average rush-hour load of more than five passengers for every two seats.

Dominating Japan's railroad scene is the Japanese National Railways (JNR), a public corporation operated under the supervision of the government's Ministry of Transport and the largest business enterprise in Japan. Dozens of private railroads also serve the major urban centers as well as mountain resorts and farming towns. However, twice as many passengers travel on JNR-owned trains as on the private railways.

Trains came relatively early in Japan's modern history. The first rolling stock was purchased from the British in 1872 to inaugurate a line between Tokyo and Yokohama, although Commodore Perry had brought along a model railroad with him nearly thirty years before. Without any other means of efficient overland transportation, the Japanese government has supported its railroads from the beginning.

In 1964 Japan ushered in a new era of high-speed rail travel by putting the world's fastest train into regular service. This coincided with preparations for the Tokyo Olympics, the first Olympic Games to be held in Asia. The route followed the historic Tokaido Road, the traditional commercial corridor between eastern and western Japan.

Today the New Tokaido Line's *Shinkan-sen*, or Bullet Express, still clips along the scenic Pacific seaboard route, past majestic Mt. Fuji, at 130 miles per hour. Its specially constructed, elevated roadbed helps reduce the 320-mile trip between Tokyo and Osaka to precisely three hours and ten minutes (it took six hours and forty minutes before 1964 and nearly two weeks on foot 100 years ago).

Today's modern line is further distinguished by its automatic safety and traffic-control systems. Not the least of its highly sophisticated safety gear is a seismoscope, which, in the event of an earthquake exceeding a certain intensity, automatically cuts the power off in the affected area.

A few weeks ago I stepped aboard the No. 23 *Hikari* ("Light," referring to the speed of light) Bullet Express at Tokyo Station just before its 7 a.m. departure to Nagoya, 150 miles away. In the buffet car I ordered the breakfast special: tomato juice, roll and butter, two poached eggs, and coffee. The bill was 250 yen, or 80 cents. Because of the short run, the menu selection in the buffet cars (two for each sixteen-coach train) was limited, but vendors in the passenger coaches provided ample extra refreshment. The Japanese heart specialist seated beside me at breakfast said that he now treats nearly as many patients in Tokyo as in his hometown of Ise, since the Bullet Train has cut his commuting time by a third. Fifty minutes out of Tokyo, we gazed at snowcapped Mt. Fuji for a full ten minutes of live, close-up enjoyment as we raced from Mishima to Shizuoka.

My reverie was interrupted by the call of the vendor approaching down the aisle. *"Odawara bento, ikaga desu ka?"*—"How about an Odawara-style lunch box?" So the Tokaido tradition of treating travelers to such local food specialties as vinegared seaweed, pick-

Fifty minutes out of Tokyo, the Bullet Express whizzes past Mt. Fuji.

David Bartruff is a freelance writer and photographer who lives in San Anselmo, California.

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TRAVEL

led radishes, and smoked squid endures, even aboard one of the most modern trains in the world.

With $700 million yearly revenues, the success of the New Tokaido Line especially delights the temporarily beleaguered JNR management. Only nine of its 247 lines show a profit. Because of the escalating wages of its half-million employees, its obligation to maintain services even on unprofitable routes, and the huge commuter discounts (as much as 89.6 per cent off normal fares), the JNR is currently losing $50 million annually. (Commuters, who make up 67 per cent of the passenger volume, account for just 15 per cent of revenues.)

Despite the current financial adversities, the future of Japan's railroads is as bright as the country's emblematic rising sun. As part of a National Development Plan, the government will finance a nationwide high-speed railway system. By mid-1980 a ribbon of rails will tie the four major Japanese islands together for the first time ever by a series of suspension bridges and undersea tunnels.

Japan's supertrains have encouraged other railroads of the world to introduce new, faster services. France's Turbo trains will soon increase their maximum speeds from 80 to 125 miles per hour. By constantly upgrading their services, the French railroads attract 600 million passengers a year. And Amtrak's fast East Coast Metroliners and Turbo Trains are heavily booked, proof that fast efficient railways can lure commuters off the highways.

Not long ago a U.S. cabinet member in Japan for a conference had to return to Tokyo on short notice. Had he been back home, of course, he would have gone by jet or car. But his Japanese hosts bundled him off to the local train station in time to catch a Tokyo-bound express. No sooner had the official and his aide slid into their seats than the departure ritual began.

A soft warning bell sounded twice. The doors slid silently shut, and, without so much as a slight jerk, the train began to glide out of the station. Chimes sounded, and over the loudspeaker came a lilting feminine voice. She welcomed the passengers aboard, announced the schedule of seat and dining-car service, and wished everyone a pleasant trip.

As the first of the uniformed little tea girls began to move down the aisles, the cabinet member was heard to sigh, "Now if we operated our trains like this back home, we wouldn't have to worry about generating traffic or running in the red." □

LETTERS

Wolf Tales

Thanks for Edward Hoagland's "Wolves and Men" [*SR of The Sciences*, December]. It reminded this old wolf impersonator of an experience inspired by a reading of Peter Krott's *Bears In The Family*. In his book Krott describes two bears he had raised from infancy. When Krott howled like a wolf, the bears panicked, ran fifty yards to a fir tree, and scrambled to the top. Krott was convinced that the bears' reaction was purely instinctive, since they had never seen or heard a wolf in their young lives.

Three friends joined me in testing Krott's theory one summer in Yosemite's back country. At a campground garbage dump, where five bears were enjoying the leftovers, we hid behind a dense growth of small lodgepole pines and, on silent signal, began a quartet of unrehearsed, bloodcurdling wolf howls. The result was magic. With a rattling of cans and deep grunts, the bears were out of the pit and into the forest in seconds.

Eugene J. McAllister
Lompoc, Calif.

That Headachey Feeling

Dr. Farr deserves high praise for his article "Aspirin Good News, Bad News" [*SR of The Sciences*, December]. He performs a service by alerting the public to the fact that there are risks as well as benefits to be expected from the use of aspirin. However, the same can be said of most drugs, including those he recommends as a replacement for aspirin.

Dr. Farr's statement that sodium salicylate, unlike aspirin, is almost totally unable to inhibit the formation of prostaglandins is half true. It all depends on which prostaglandins we are talking about.

The inhibitory effect of sodium salicylate on the biosynthesis of certain prostaglandins probably accounts for the fact that sodium salicylate shows the same potency as aspirin in antipyretic and anti-inflammatory tests. A large part of the analgesic activity of aspirin (acetylsalicylic acid) is due to salicylate released by hydrolysis of aspirin, since, after the ingestion of aspirin, about 75 per cent of the dose is present in the bloodstream as salicylate.

Ralph Hollands, Ph.D.
Willard Johnson, Ph.D.
Ottawa, Canada

More on the Metric System

Many of the diagrams accompanying Frank Kendig's article "Coming of the Metric System" [*SR of The Sciences*, December] are confusing, and some of the implications are misleading. The Kelvin scale is generally not used in ordinary circumstances; countries using the metric system report the weather with the Celsius scale. The discussions of the Krypton 86 spectrum and the mole are also unnecessary. The use of the mole is not confined to the metric system, since the engineering, or English, system has a "pound-mole" that serves the same function as the gram-mole (though, of course, there are more atoms in the pound-mole). People who use the mole are already familiar with the metric system.

The article implies that the watt and the ampere are unique to the metric system. This is not true. Even one of your examples —the 100-watt bulb—shows that these units are common in the United States.

And what are the costs and benefits of conversion? Mr. Kendig tells us that the U.S. exports of "measurement sensitive" products could be increased by $600 million by 1975 if we switched to the metric system. This represents only a 4.3 per cent increase over the 1969 figure of $14 billion. Does this gain justify the expenses of conversion? Mr. Kendig sheds no light on this question.

I am in favor of using the metric system; however, it must be "sold" to the American public.

Frank A. Dougherty
Chicago, Ill.

Indians as Artifacts?

I enjoyed the article "Resurrection in Illinois" by John Ronan [*SR of The Sciences*, December]. For too long a time foreign archeology projects have been publicized in the United States, while archeology here has been thoroughly neglected (except by U.S. scientific experts and journals).

Perhaps the public has been overfed by TV that the American Indians were dirty, murderous, and otherwise not fit to live.

Mrs. Francis C. Smith
Atlanta, Ga.

John Ronan's comparisons of life expectancies would have been more revealing had he also included current figures for Indians. The average life span for Indians today is forty-four years, better than the twenty-three-year average of the Mississippians at Dickson Mounds, but a far cry from the average American life expectancy of seventy years.

Indian health care is still inferior to that received by most other Americans, despite the fact that federal and state governments are legally obligated to provide free health services to all Indians with tribal connections. Infant mortality rates are twice the American average, and the gap is widening.

Patricia Jo Goering
Monroe, Wash.

SOLUTION OF THIS WEEK'S KINGSLEY DOUBLE-CROSTIC (No. 2024)

(TERRENCE) O'FLAHERTY:
I ATE THE WHOLE THING
(On Dick Cavett and Jack Paar)

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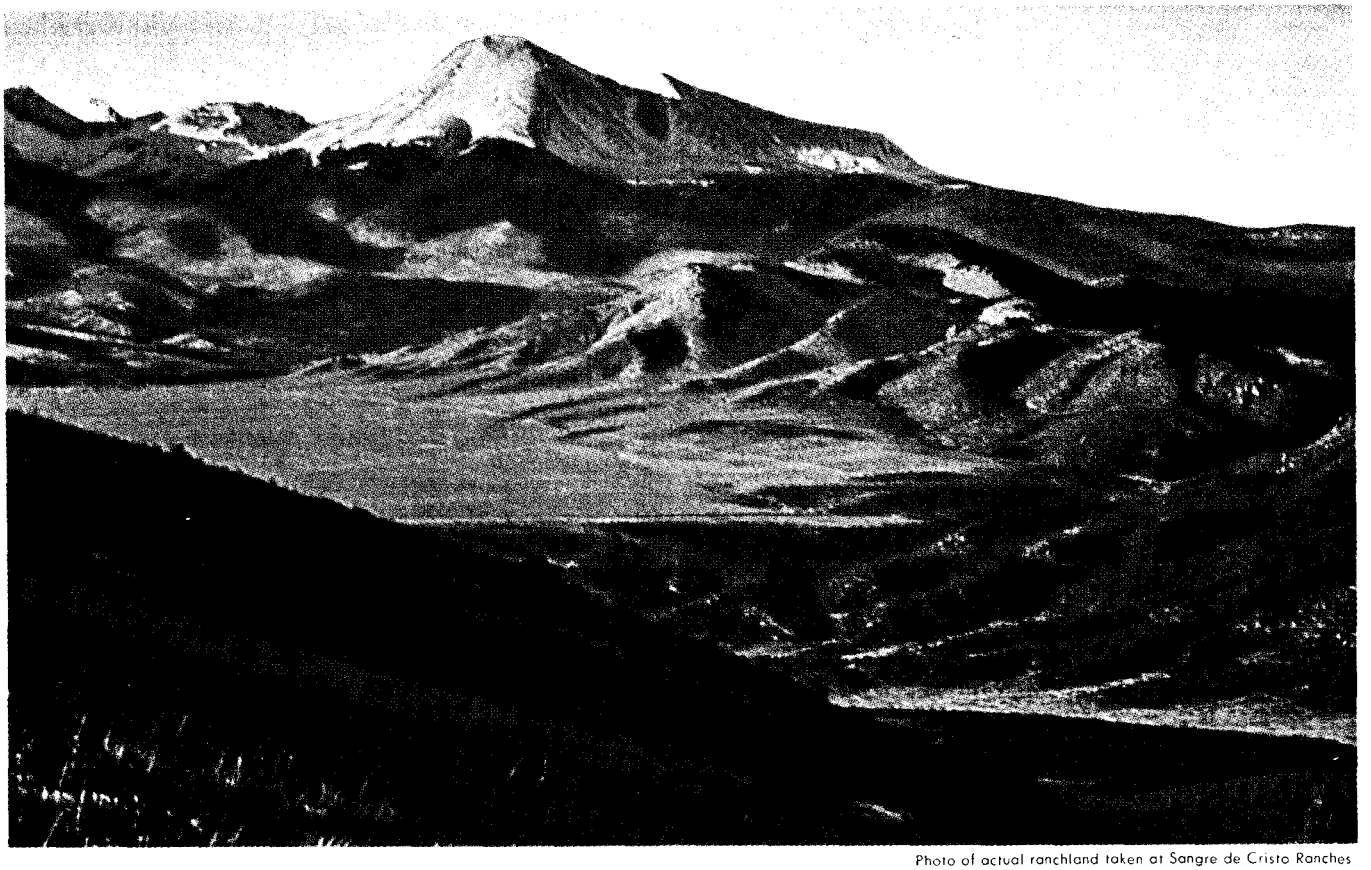

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EDITORIAL

Gods and Devils in Science

With an abruptness that many scientists find bewildering, the organized pursuit of knowledge has fallen upon hard times. Science, which one Nobel Prize winner described as "doing your best with your mind, no holds barred," has been accused of complicity with the military-industrial complex and indifference toward the social uses of its results.

While the latter charge is not a new one, it has been revived recently by a number of critics, most notably historian Theodore Roszak. In *Where the Wasteland Ends* he calls into question not only the dubious applications of basic science but also the extreme reductionism implicit in the "scientific method" that may ignore human values and perceptions.

Ironically, the largest forum for the exchange of ideas about science—the American Association for the Advancement of Science—has itself come under sharp attack recently for moving too slowly toward reform. The AAAS has traditionally produced two products: an annual meeting, which attracts some 8,000 people and has been likened to a circus without a ringmaster, and the monthly magazine *Science* (circ. 163,000).

The annual meetings, begun 125 years ago, when scientists were few and far between, long fostered an elitism that did much to shape the image of the experimenter in his ivory tower. As long ago as 1951 a policy meeting in Harriman, New York, resolved to move away from "the more detailed and more isolated technical aspects of science" toward "broad problems that involve the whole of science, and relations of science to government, and indeed the relations of science to our society as a whole." This resolve was all but ignored until the late Sixties, however, by which time the elitism and isolation of science had become unforgivable in the eyes of many people. By then there had begun to appear at the AAAS meetings threatening bands of students and young scientists loosely organized under such titles as Scientists and Engineers for Social and Political Action (SESPA) and Science for the People (SFP). These groups strenuously protested the misuses of science and the scanty application of science to social problems. A series of annual-meeting incidents sprang from this sudden clash between radical thought and traditional science, such as the tomato bombing of Hubert Humphrey in Philadelphia, the knitting-needle stabbing of an SESPA stalwart in Chicago by a biologist's wife, and a number of nonscientific wrestling matches. Many AAAS leaders, who like to think of their group as a sort of "lower house" of science, realized for the first time that the ivory tower was under siege.

As a result, at least one member of the AAAS board of directors boycotted the 1972 meeting, and a doctor who has been president of the Youth Council is resigning because "the AAAS is not paying serious attention to us." The society claims it is doing a lot. At the last meeting, for example, nine of the thirteen AAAS-organized symposia (as opposed to the more specialized programs of the affiliated societies) were devoted primarily to various social aspects of science, such as "Science Reporting via Television," "Anti-technology Sentiments," and "Crime Prevention." "Ten years ago," comments physicist Gerald Holton, who with Margaret Mead, Barry Commoner, and Bentley Glass has worked for reform over the last decade, "these would have been rather unusual kinds of activities."

Perhaps the biggest plunge taken by the AAAS into public involvement was the herbicide study led by chemist Matthew Meselson of Harvard. The results were a key element in the government's decision to halt defoliation in Vietnam. Soon to be released is another study called "Electric Power Consumption and Human Welfare," an exhaustive analysis of energy problems. In addition, the AAAS is considering future projects on population and the social relevance of institutions, colloquia for congressmen, and an internship program for young scientists on congressional staffs.

The current management of the society is determined to reach out to the public through a whole range of ambitious programs. A pivotal figure is the new executive officer, William Bevan, Jr., who is concerned with the role that should be played by the AAAS's 290 affiliated societies. These range from the 120,000-member American Chemical Society to the tiny American Malacological Union, whose chief interest is clam biology. Their "meetings-within-meetings" are too specialized for the public.

Some of the members of these affiliates are unhappy. The 4,000-member American Society of Zoologists, for example, decided overwhelmingly to discontinue meeting with the AAAS. "The AAAS meeting is getting away from the kind of basic science that ASZ is involved in," says society president John Corliss. "We have to remember that most of science's greatest accomplishments have come out of the mundane work we do in the lab."

Affiliates also have money complaints, since the AAAS began charging them for meeting expenses in 1970. The AAAS feels that these complaints are unfair, since the society regularly takes a substantial loss from the meeting ($125,000 in 1971), and that the indifference of many scientists to public communication may be one reason for the public's hostility toward science and the decline in science funding. Says current president Leonard Rieser, "You aren't going to get that accelerator if you don't have public support. The individual scientist is also a citizen of this country, and he cannot be indifferent to the use of technology." The AAAS will hold a major meeting next fall to review the nature of its mission and will almost certainly broaden its efforts to convince the public that science is not the bane of mankind.

One step in this direction has been taken with the creation of an educational committee headed by Gerard Piel, publisher of *Scientific American*. Another logical step would be to acknowledge that to understand science, the public must understand scientists, and this is clearly impossible in an elitist or isolationist system. The now-unwieldy annual meeting, for example, might be a genuinely effective forum for communication if more scientists were willing to act as "interpreters" for the press and other laymen. Scientists should spend more time advising governments, from Capitol Hill to the smallest-town boards of supervisors who must accept or reject a nuclear power plant. In its own turn the public must realize that scientists are human and that "experts disagree" in this supposedly objective realm just as they do in art, politics, and ethics. More scientist-layman contact is the only way to destroy the myth that scientists are, depending upon the latest horrors of CBW or miracle cures from the laboratory, either gods or devils.

ALAN ANDERSON JR.

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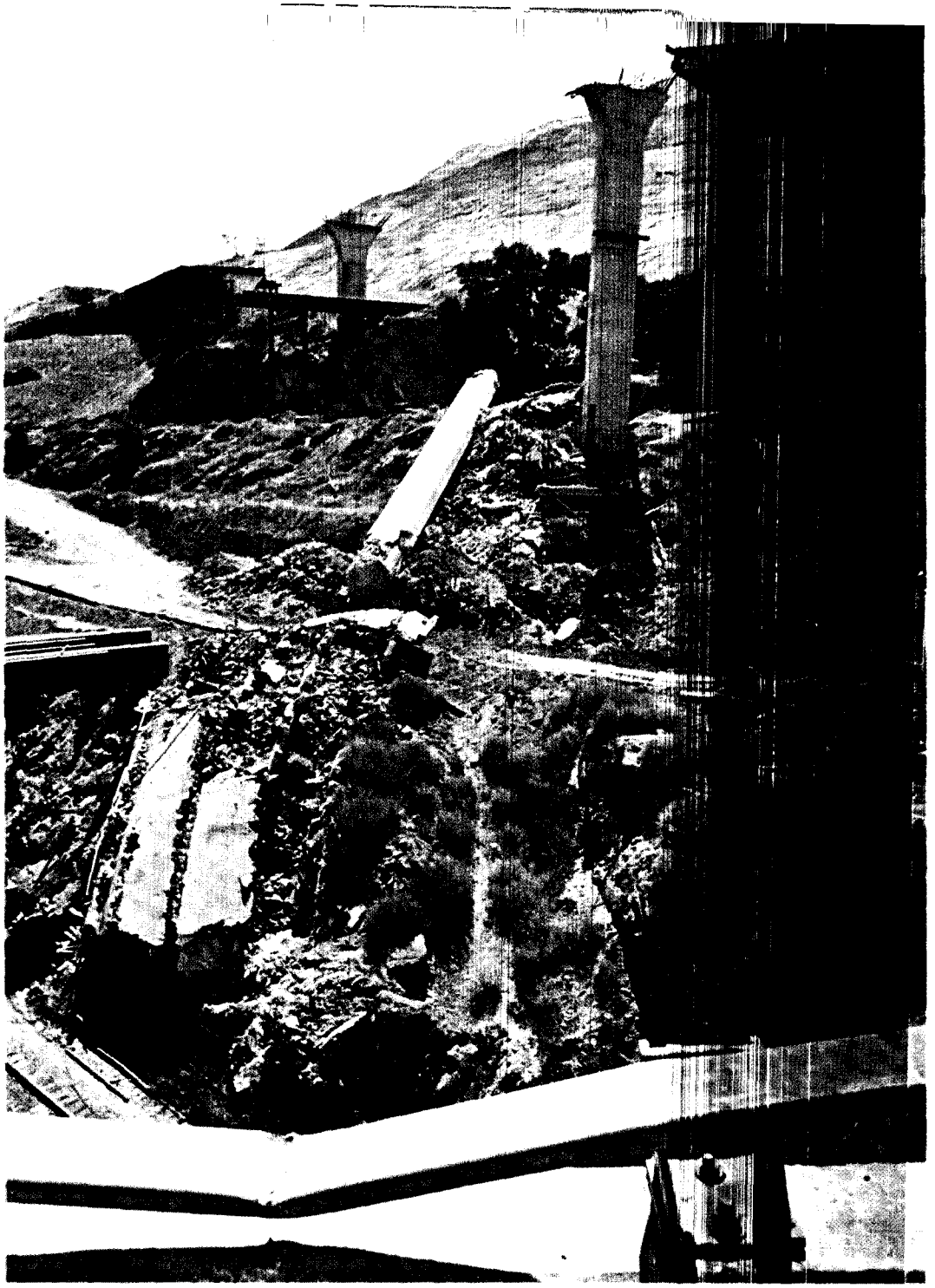

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EARTHQUAKE PREDICTION

The Art of the State

Despite a swelling bag of technological tricks, the forecasts of seismologists must still compete with those of astrologers and cranks in quake-prone California.

BY ALAN ANDERSON JR.

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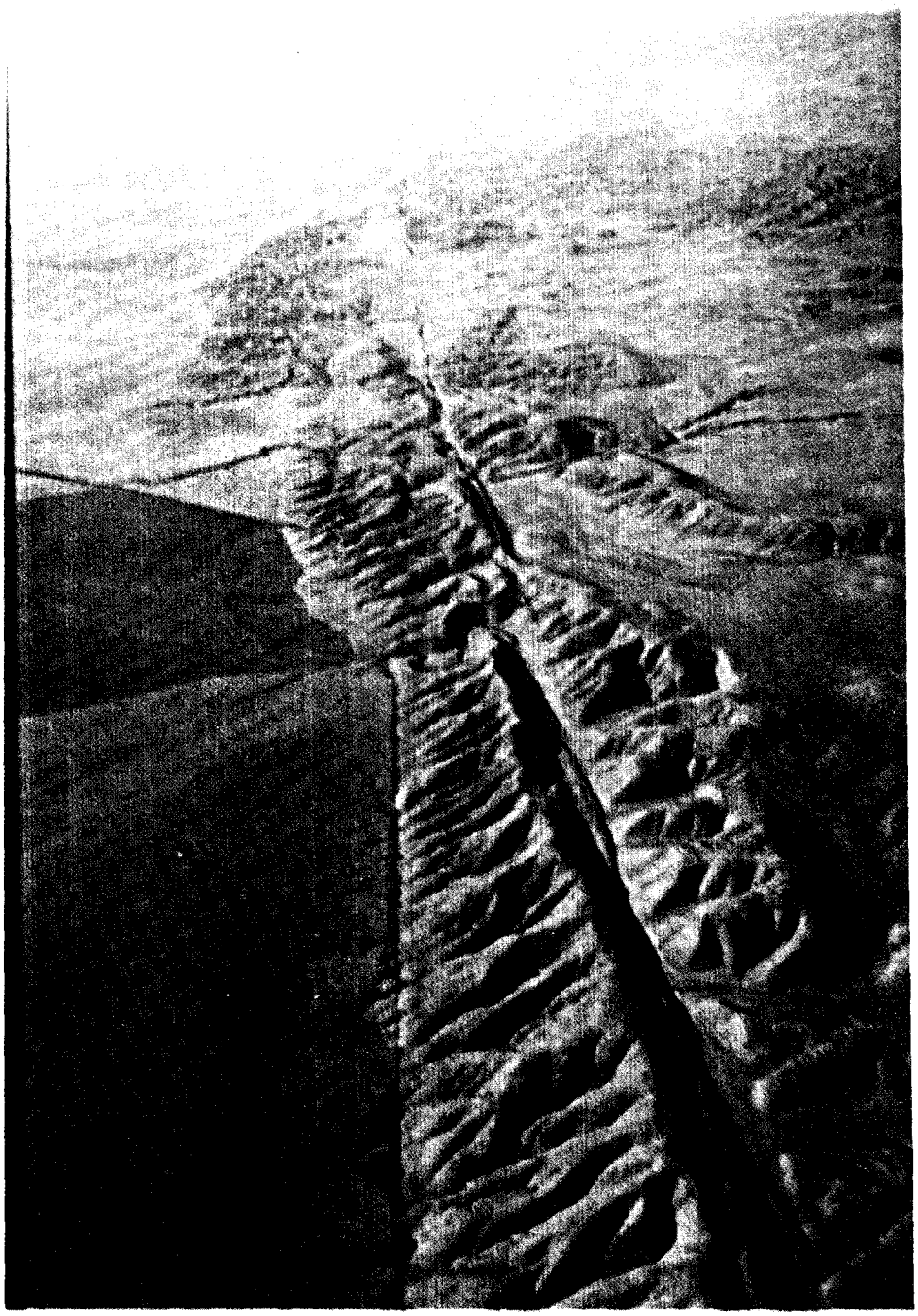
When the news began to spread last fall in San Francisco that a great earthquake would strike on January 4, 1973, the depth of quake phobia in that city was quickly revealed. People began asking each other where they would be "for the quake," and because the fourth fell on a Thursday, it became fashionable to schedule long weekends far from the coast. "Where's the best place to watch the Golden Gate Bridge fall down?" asked a newcomer to the area. "From a sailboat in the bay," answered an old-timer. A lawyer's aide who had business in Peoria on the fourth felt ambivalent. "If the city is going to go," she said, "I guess I'd like to go with it."

The source of the frightening prediction was a sixty-six-year-old physicist-recluse named Reuben Greenspan, who experienced a brief period of notoriety during the mid-Thirties, when he sent quake-forecasting letters to the *New York Times* and other publications. Many of his predictions were on or near the mark, and although they tended to be vaguely worded, he soon acquired a reputation in psychic and astrological circles. This reputation was augmented by the testimony of John Blackburn, a reporter for the *Santa Ana* (California) *Register*, who says that Greenspan correctly foresaw the 1971 San Fernando disaster near Los Angeles that killed 64 people, wounded 2,500, and destroyed half a billion dollars' worth of property.

Days before the predicted San Francisco quake, however, Greenspan amended his date by a few days, then canceled it altogether. Under heavy fire at a press conference in Palo Alto, the goateed eccentric blamed his lack of computer facilities. "In manual calculation," he explained nervously, "there is always the possibility of error. I'm overjoyed because the earthquake will not occur and saddened by all the distress I've caused people."

The city relaxed—somewhat. With the memory of the Nicaraguan disaster still fresh, it was hard for jittery Californians to let their breath out or to believe the disclaimer more than the prediction.



The San Andreas Fault slashes dramatically across the barren Carrizo Plain 100 miles north of Los Angeles.

Greenspan had not discussed his theory with orthodox seismologists, but it is based upon a geophysical model first published in 1922, involving the likelihood that earthquakes are more probable when the moon is new—i.e., when tidal stresses upon the earth are maximal.

Such a formula is anathema to more conventional geophysicists. Charles Richter, deviser of the Richter scale of earthquake magnitudes, responded to a query about Greenspan with "Isn't he dead yet?" Richter went on to call the man a fool and a charlatan. Jerry Eaton, head seismologist at the U.S. Geological Survey in Menlo Park, objects to Greenspan's "warmed-over version of the old tidal theory," saying that his successes in the Thirties depended upon sufficiently vague predictions made for quake-prone areas. "If he seriously wants to prove his theory," says Eaton, "he's not going about it in the right way. If he wants to get his name into print, then he is."

Although virtually all seismologists agree that no one has yet a sure-fire way of predicting or preventing earthquakes, they are trying hard. The

Alan Anderson, Jr., is a senior editor of SR of The Sciences.

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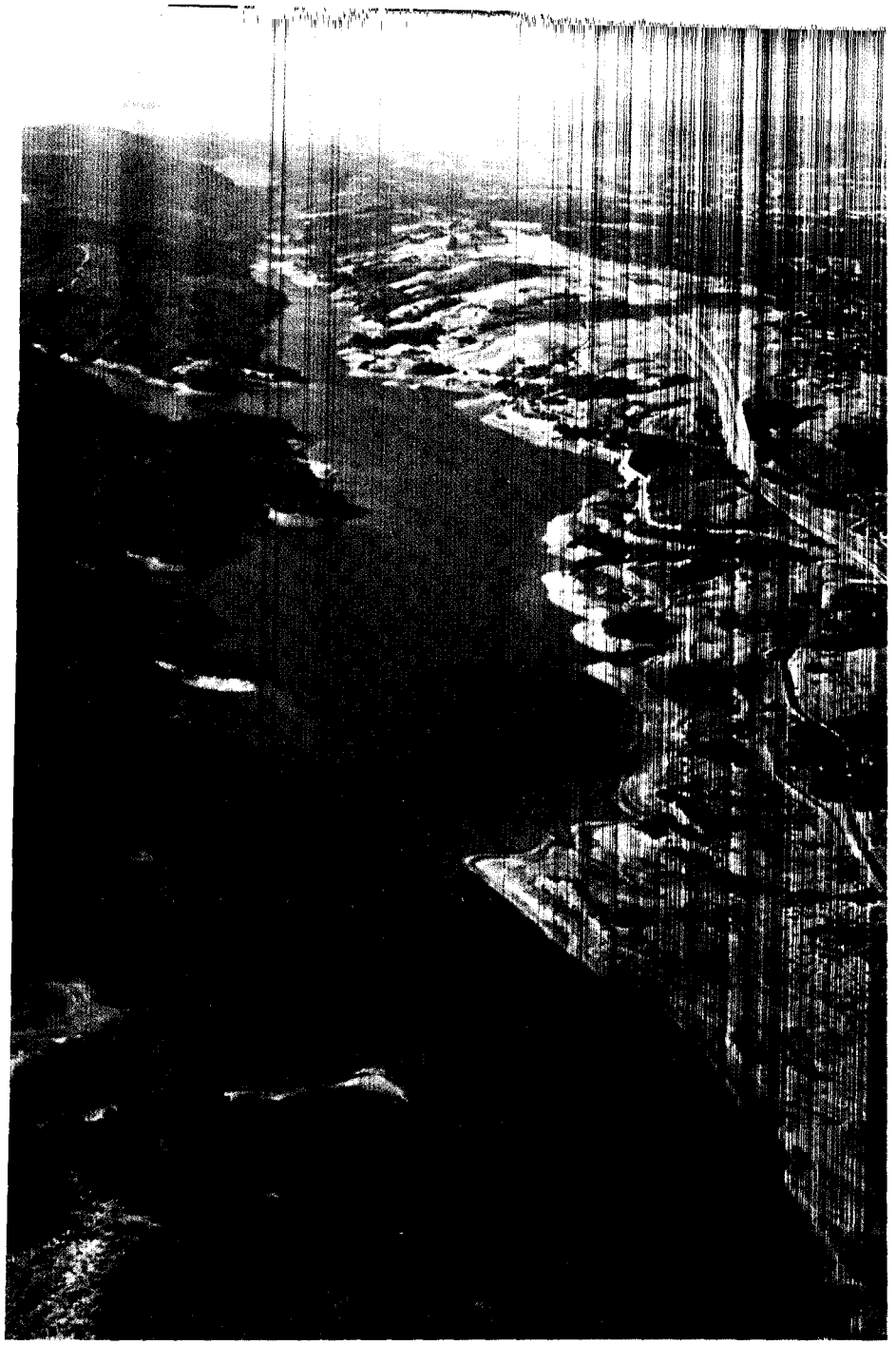

The San Andreas Lake, after which the fault is named, formed when the fault interrupted underground water flow just south of San Francisco.

mention of prediction and prevention doesn't hurt the chances of a grant proposal, for that matter, and each time the country endures a 1964 Alaska quake or a 1971 Los Angeles quake, there is a peak in public support for anti-quake research.

The fledgling science of seismology has grown just enough so that the first bold theories have been weakened. Three years ago four geophysicists at Menlo Park produced a major paper estimating that earthquake prediction and possibly even a demonstration of preventability might be possible in a decade. Clues were coming in fast, so fast that it seemed at least one of them would lead directly to a formula for prediction: perhaps changes in the earth's magnetic field or the tilt of the earth's surface or the rate of movement at the few places where faults (fractures in the earth's crust) are slowly creeping. None of them has yet proved to be the unique indicator.

Of course, there is a larger reason for the boom in seismology: the revival and broad acceptance of an updated version of the theory of continental drift, first proposed by the German meteorologist Alfred Wegener in the second decade of this century. Continental drift, better known now as plate tectonics, posits that the earth's crust is not a single, unified layer but a discontinuous series of about a dozen sixty-mile-thick plastic plates that move about on a viscous mantle. These plates are thought to be created along hot ridges in the ocean floor, such as the Mid-Atlantic Ridge, and to disappear down ocean trenches, such as the Aleutian Trench. When they scrape past each other or when one is forced downward past another into a trench, earthquakes occur.

California is the seismic research mecca of the United States, because two of these plates—the Pacific and North American plates—are shifting past each other along a boundary that slices through the state. The boundary region, extending about 650 miles from the Gulf of California to Cape Mendocino, contains a complex series of faults, the longest and most famous of which is the San Andreas Fault. The San Andreas region is actually a combination of hot seams deep below the continent and "strike-slip faults," where the southwestern extreme of the state, including Los Angeles, strikes against the mainland as it slips past in a northwesterly direction. Much of the irregular hot vein below parts of the San Andreas Fault may also affect eastern California and even Nevada and Utah.

In the mid-Sixties, when the evidence for the plate tectonic theory was gathering, geologists were feverish with excitement. Many assumed that this large-scale explanation for earth movement would soon be followed by such details as the timing and placement of earthquakes. In 1966 the U.S. Geological Survey established the nation's largest earthquake-research facility in Menlo Park to work out such crucial details, and this lab, with Cal Tech, Berkeley, and other seismological powerhouses, began wiring the state for tremors. Although a miracle key has not been found for unlocking earthquake secrets, geologists are at last discovering what has to be learned.

One of the most intensively monitored phenomena, until recently thought to be endemic to California (it has now been observed in Turkey), is fault creep. The process was first suggested in 1933, when an oil company engineer named Thomas Koch discovered that his oil drills were being bent and broken in a Southern California thrust

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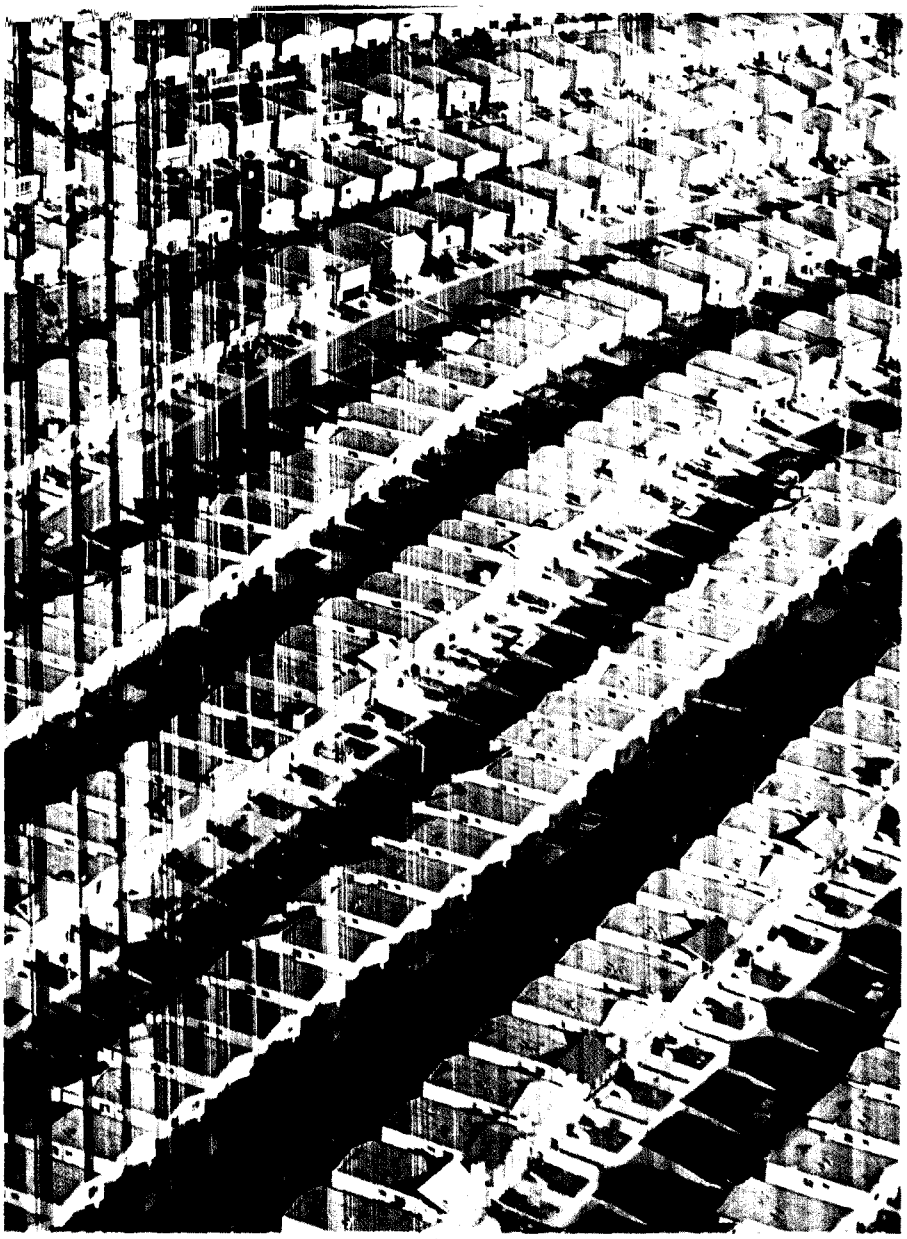
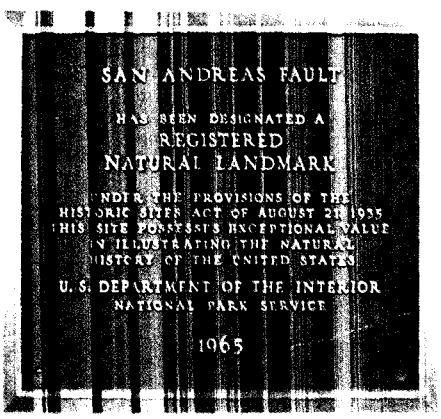
fault and, further, that the fault had moved some forty inches since 1910, when drilling began. However, the "official" recognition of creep did not come until 1956, on the site of the Almaden winery near Hollister. This city, located between two faults and astride a third, is often regarded as the earthquake capital of the country, trembling a dozen times a year. The winery had foolishly been built in 1939 on the site where an older building had collapsed; since then the west side of the winery has crept more than a foot in relation to the east side. In one quake a huge Almaden storage tank ruptured; red wine flooded the road outside, turned a nearby pond red, and caused neighbors to rush outside with buckets and ladles. In 1956 the owners, smarting from frequent quake damage, tried to get insurance; an alert insurance agent noticed that on his map the building was bisected by a strange-looking line. The line turned out to be the San Andreas Fault. Karl Steinbrugge, perhaps the nation's ranking expert on the effects of earthquakes on buildings, was called in, as was seismologist Don Tocher, now head of San Francisco's Earthquake Mechanism Laboratory. The fault at the winery was quickly instrumented, and the two men formally announced the existence of "creep."

Seismologists now are busy deploying as many creepmeters as they can afford. The heaviest instrumentation in the country is found between Hollister and Hayward, where the San Andreas Fault is creeping as much as an inch or two a year. Creep is even taken for granted in downtown Hollister and, farther north, in Hayward, where the Hayward Fault is slowly pulling houses and streets apart. At the corner of Rose Street and Prospect Court curbs are being bent, or offset, by the sliding motion of the opposite sides of the fault, and "stretch marks" mar the asphalt streets. The sidewalk along nearby B Street has been offset nineteen inches since it was laid in 1913 in the oldest part of town. "You could really see these offsets if they hadn't put the houses in the way," complains Don Tocher.

Strangely enough, the tendency of clustering houses around the fault made good sense at one time. When blocks of the earth's crust are shifted along fault lines, underground water flow tends to be interrupted, forming sag ponds or lakes (such as San Andreas Lake—from which the fault gets its name—just south of San Francisco). Early settlers in dry California found these natural reservoirs invaluable for watering livestock and crops. Hence people got in the habit of building on faults before they knew what they were, and even now there is little outcry when the Hayward Fault—one of the state's most active—is chosen as the foundation for such structures as the University of California, Berkeley, football stadium, numerous freeway overpasses, a Mormon temple, and part of the new BART subway line. Stanford's linear atom smasher lies only a mile from the San Andreas Fault. As a result of such nonchalance, earthquake insurance is often impossible to buy. "The natives have accepted the fact that there's going to be another quake," says Charles Ford of Fireman's Fund Insurance Co. "They just say, 'What the hell.'"





This development in Daly City, just south of San Francisco, sits directly astride the San Andreas Fault. Plaque at left was placed at the Almaden winery in Hollister. Buildings at the winery, which straddle the fault, have been torn apart by subsurface pressures.

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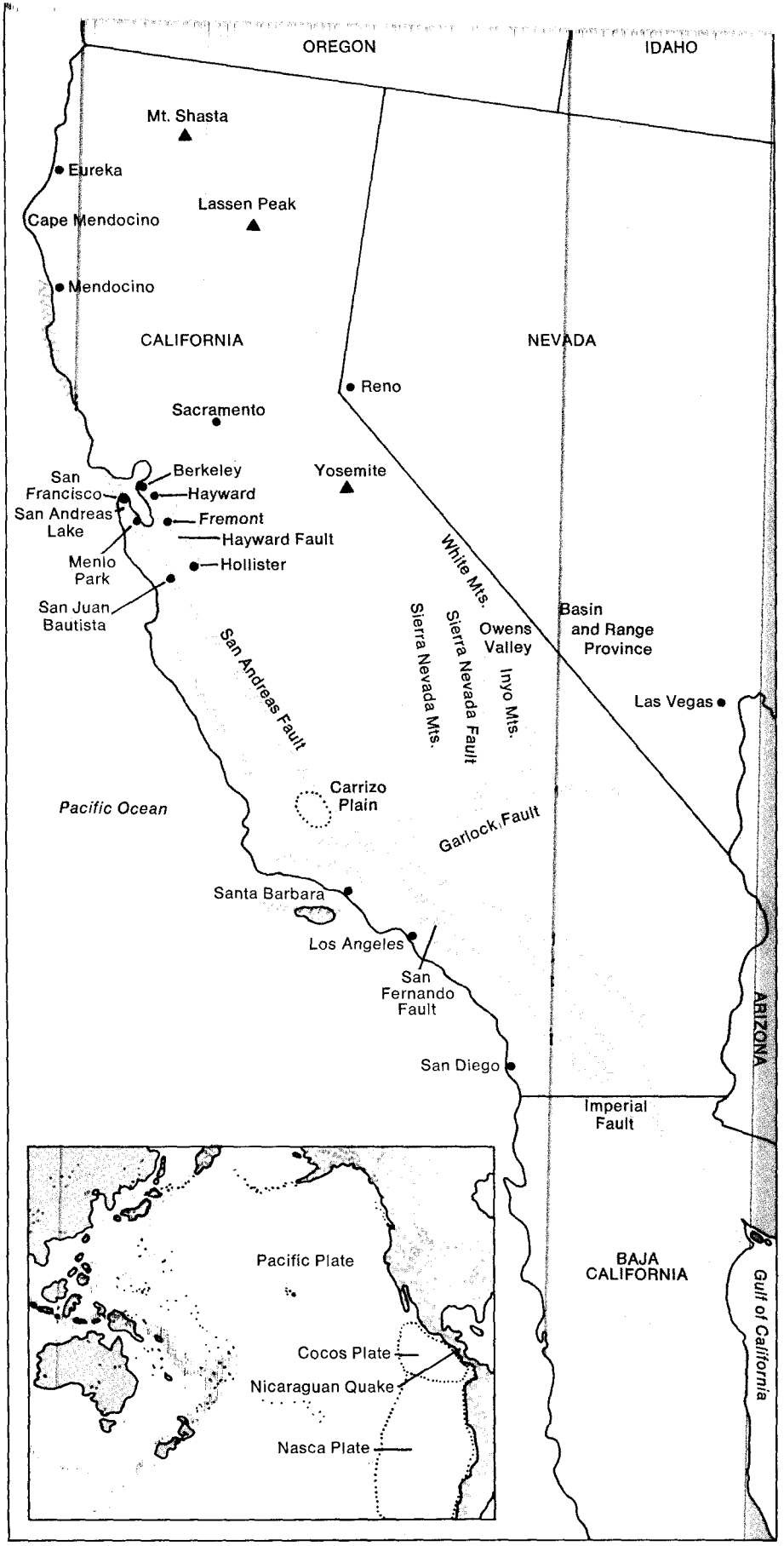

While California is laced by over 2,000 miles of menacing faults, most of the neighboring states are also earthquake-prone. Insert shows the "rim of fire," where some four-fifths of the world's quakes occur. Most are caused by the descent of oceanic plates down trenches that mark the boundaries of adjacent plates. Delineation of this active zone was accomplished largely through the study of seismology.

The basic tool for studying creep is a simple extension device known as the creepmeter, consisting either of a rigid metal-alloy rod or wire attached to pillars on either side of a fault. Creepmeters are usually installed in twos, at right angles, so that, depending upon how they are oriented across a fault, they measure fault creep by the lengthening or shortening of the distance between the pillars; for example, a parking lot at D Street in Hayward is creeping at just less than an inch a year.

However, simple creepmeters are normally only a few yards long and useful only for simple, well-defined faults. Where zones are broader, surveying tools or even lasers are used. For example, on Mission Vineyard Road, just south of San Juan Bautista, the U.S. Geological Survey has set out sixteen permanent markers across a slump in the road. The slump, noticeable in a fallow field on one side of the road and in a vineyard on the other, marks the creeping San Andreas Fault.

Using a theodolite and a surveying target, seismologists from Menlo Park find that month by month their markers are twisted from the original straight line into an S shape as the sliding San Andeas Fault produces *en échelon* cracks in the road. Belying the bucolic peacefulness of the vineyard, this stretch of land, along with two other sites south of nearby Hollister, is one of the most unstable in the world. The nearby mission in San Juan Bautista, built by Spaniards to Catholicize American Indians, gave up yet another section of its seismically scarred outer wall in a quake last September, when a pile of bricks fell outward toward the old track of El Camino Real. A tantalizing earthquake clue appeared just before the quake. The ground crept markedly just twenty hours before the tremor, lending support to those who argue that creep events may signal earthquakes.

For even wider fault zones, such as the Hayward Fault near Fremont, lasers are now used in measuring movement. Each month Menlo Park geologists measure the distance between Coyote Hills and Allison Peak with a Geodolite, which can throw a laser beam forty miles even in daylight. This $50,000 machine emits a flickering, pen-

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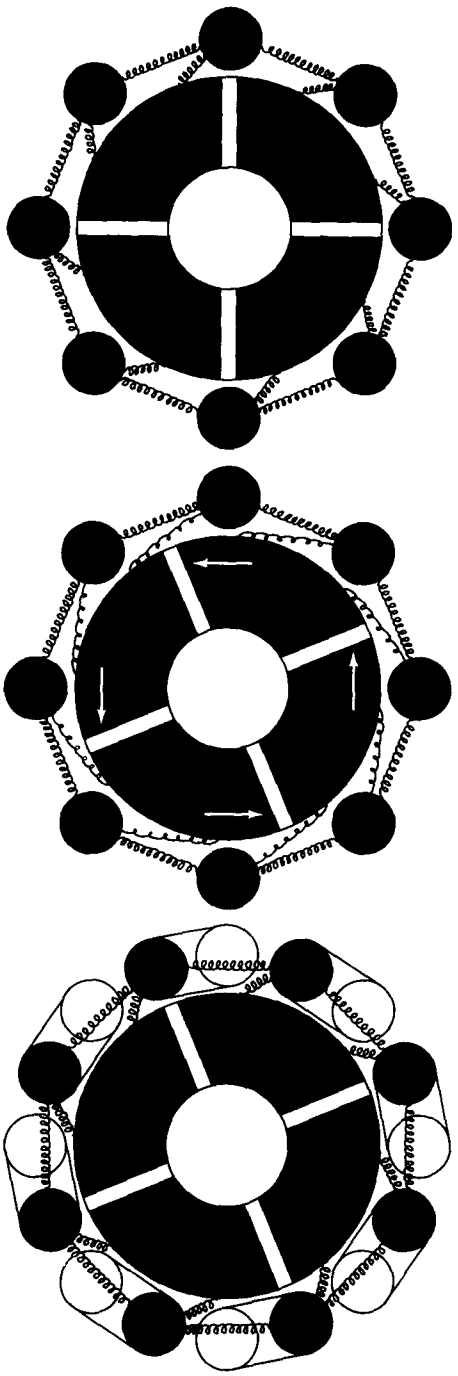
cil-thin beam of red light toward Allison Peak, twelve miles away, hitting a target of twenty-four corner-shaped reflectors of the same type placed on the moon to measure earth-moon distance. Through an eight-inch telescope built into the Geodimeter, one can see a winking ruby pulse returned when the beam hits the reflector. During recording, a thermometer-equipped Cessna airplane is flown on a straight line between the two peaks; air temperature must be known, because the velocity of light, although constant in a vacuum, varies in the atmosphere with temperature and the measured distance depends upon the velocity of light along the path between instrument and reflector. This section of the Hayward Fault is moving at about half an inch a year.

Seismologists disagree on the significance of creep: some believe that it relieves the strain on faults, reducing the likelihood of a major quake. Others think that creep events may warn of greater activity to come. The dispute is more than academic, because the major fault sections near Los Angeles and San Francisco have been locked since 1856 and 1906, respectively, but may give way at any time. The proliferating creepmeters, mostly installed during the past few years, should yield an answer to this question as the next few large quakes provide live field tests.

Appropriately enough, seismologists compile almost all of their quake-behavior data during large quakes, the only time when their theories can realistically be tested. Because one must be quite close to a large quake to really prove anything and there is not enough research money to make this possible for the 2,000 miles of faults found in California alone, knowledge accrues slowly. Only a few attempts have been made to reproduce earthquakes in the lab. A simple one is now operated by Chi-Yu King of the National Oceanic and Atmospheric Administration (NOAA) in San Francisco. Using four-ounce cans that once held Gerber's apple-cherry juice, Dr. King has constructed a fault model consisting basically of eight cans arranged around a twenty-inch circular metal plate. With it he calculates how much is needed to move the juice cans, which are sitting on a wooden platform and linked together with delicate springs.



In this simple "earthquake machine" the lurching of juice cans, interconnected by delicate springs, affords geophysicists a crude means of emulating earthquake activity in the Earthquake Mechanism Laboratory in San Francisco.

The principle of this deceptively simple system is that the friction of the cans sliding on the wood corresponds to two tectonic plates scraping past each other along a fault zone. When one can breaks free, its effect upon the cans ahead and behind it via the springs simulates the effect of an earthquake upon adjacent fault sections. The details of the juice-can movement are recorded, computerized, and analyzed; and they are, according to Dr. King, amazingly close to the motions of the real thing (with the exception, of course, of magnitude: someone in a fit of flamboyance has calculated that the next great quake in San Francisco will release enough energy to power the U.S. Sixth Fleet at flank speed for 500 years). One comforting result of Dr. King's program is his claim that there is no such thing as a magnitude-ten quake: his computers have put theoretical limits on the maximum possible size at about that of the 1906 San Francisco quake or the 1964 Alaska quake, both about magnitude 8.4. Although there are still a few ticks to be worked out of the juice-can model, it at least allows mathematicians a limited facility to test their fault models without having to wait for an earthquake.

Another clue to earthquake generation—the slight tilting of the ground—is being investigated by Rex Allen and other geophysicists of the U.S. Geological Survey. Allen found an obscure spot that is both sheltered from temperature changes (which cause the ground to rise and fall) and near a major fault (six miles from the offshore San Andreas). He staked out a research area in gloomy, subterranean vaults beneath San Francisco's army garrison near the Golden Gate Bridge. The tunnels have been abandoned since World War I, when they held ammunition for sixteen-inch elevator-mounted artillery guns. In the tunnels the temperature varies only a fraction of a degree year-round, and there is no traffic or wild animals to break the seismic tranquility. This is essential, because even a swift squirrel is heavy footed enough to disturb a good tiltmeter.

Most of what geologists know about ground tilt derives from measurements on volcanoes, where outward tilt of the

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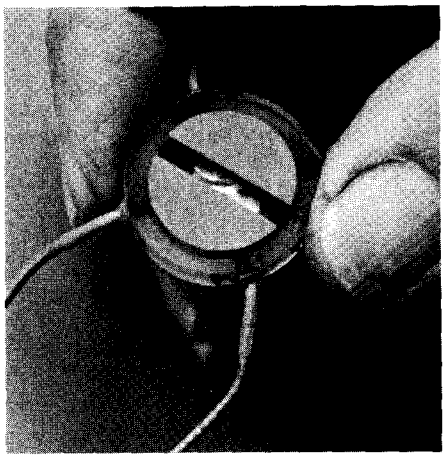
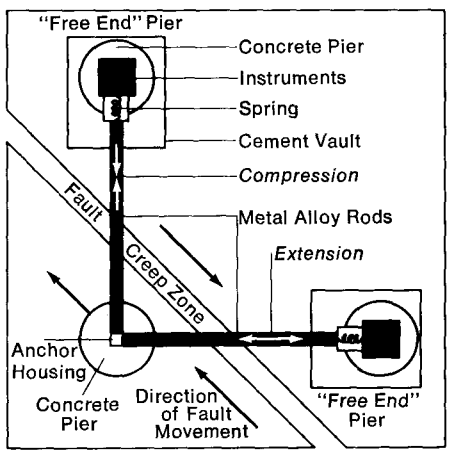
mountainsides often precedes eruption. According to laboratory experiments and field data from Japanese seismologists, there should also be tilt along a fault before an earthquake. The cause, based upon lab results, is the crushing of crystalline rock in locked faults as enormous stress is exerted by the straining plates. As the neat crystal fabric ruptures, goes the theory, the rock expands to make room for a less compact arrangement. "Toying with tiltmeters," says Rex Allen, "is more like witchcraft than science."

The Japanese are the world's experts on tilt, since the government has been coordinating for about eight years a nationwide effort to predict earthquakes. By charting the minute movements of broad stretches of land south of Tokyo, Japanese scientists have successfully predicted some quakes and are now working up their scariest forecast yet: a repeat of the 1923 Tokyo temblor that killed more than 100,000 people in one of the worst disasters of modern times.

Needless to say, tilt produced by tiny changes in rock volume can be detected only by supersensitive instrumentation. One of the most promising instruments: a nickel-sized bit of space spinoff designed by North American Rockwell that has been responsible for stabilizing the inertial guidance platform of the Apollo spacecraft. Following the principle employed in a simple carpenter's level, this tiltmeter is basically a bubble of gas trapped in a liquid. When the ground tilts, the "uphill" movement of the bubble triggers an electrical impulse. The instrument is so touchy that it can detect a light footstep on a concrete floor or minuscule variations in temperature. "It's a little weird," says Allen. "All you have to do is turn a light on, and the tiltmeter can 'see' you.

While seismologists strain to learn the site and timing of the next big quake, they find that at the same time they are answering questions about the formation of North America. Although the San Andreas Fault is practically synonymous with the word *earthquake* in the minds of most Americans, virtually no state is temblor-proof, least of all Montana, Colorado, Nevada, and Utah. And by no accident, because the North American plate has





The heart of a supersensitive tiltmeter (top) is nickel-sized. Creepmeter (center) measures slow, continuous fault movement, as does the laser (bottom), which precisely senses minute changes in distance between mountain-top markers.

been moving westward for well over 100 million years and much of the West has been created or affected by collision with the Pacific plate and perhaps several smaller plates in the Northwest. As the Pacific plate(s) was folded beneath the American plate, it surrendered sediment (which may now be identified on mountain tops in the form of marine fossils) and created such mountains as the Sierra Nevada. Then, 30 or 40 million years ago, the Pacific plate changed direction toward the north and west, creating the San Andreas Fault region and removing much of the pressure from the western United States. With the pressure removed, and probably with the hot seam called the East Pacific Rise heating the foundations of New Mexico, Utah, and Idaho, part of the West began to rise, creating such conspicuous features as the Rocky Mountains.

Seismology provides for geologists a tool they have always lacked: a system for monitoring *current* activity in the earth. Each earthquake, large or small, is a tip-off that something is up geologically. In addition, just as frequent or large quakes indicate current plate movement, smaller, infrequent quakes may indicate that a plate is going into dormancy. Hence the dots on a seismologist's map serve roughly the same purpose as those on a child's numbered drawing puzzle: connecting them creates a meaningful picture of geological behavior.

Very recent results of such advanced dot connecting have been hints of a nearly dormant plate under what is now northern California and Oregon. This plate seems to have created the Cascade Mountains, including the volcanoes Mount Shasta and Lassen Peak. The southern and eastern boundaries of this plate seem to extend inland from Cape Mendocino through Sacramento, Yellowstone National Park (where frictional plate movement and upwelling material heated Old Faithful and other hot springs), the central Nevada area, and the Great Salt Lake. The northern boundary, presumably returning to the sea through the state of Washington, is not yet clear, perhaps because it was locked during the 1961–69 period when the World Seismicity Map was constructed. "We just have to let some of these mysteries reveal themselves in

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their own good time," says Jerry Eaton. However, as the population of Nevada and Utah soars, this section of the country may be the most underrated earthquake danger zone. For example, in 1959 the Hebgen Lake quake in southwestern Montana was as large as the 1971 Los Angeles quake—but few people live in Montana. Such a shaking near Salt Lake City would be another matter.

Seismic data are also revealing the violent nature of California's history. The Gulf of California—the continental entry point for the East Pacific Rise—has been slowly opening wider as Baja California swings away from the mainland. As the continent plowed westward in the course of millions of years, the stable leading edge—now the thickly sedimented San Joaquin Valley—seems to have caught up some island archipelagos that are now the Diablo and Coast mountain ranges between San Francisco and Los Angeles. As this leading edge was compressed by plate collision, the Sierra Nevada Mountains were pushed up behind it like a rug crumpled by an opening door. Behind them, where the East Pacific Rise may be lending instability through heating, the choppy Basin and Range Province stretches eastward through Utah. The White and Inyo mountains, once part of the Sierra Nevada, seem to be breaking loose and drifting into this morass. The dividing line between the two ranges of mountains is Owens Valley, the site of one of the largest earthquakes in history in 1872.

Still farther east seismologists have found that for the first time they can undertake the work of the Almighty by initiating earthquakes. The injection of fluid deep into the rocks beneath the Denver basin produces small quakes —perhaps the result of increasing ground pressure or of fault lubrication, or both. They have also found in Nevada—by accident—that underground nuclear explosions release thousands of afterquakes lasting several months. Scientists hope that this technique can be used eventually to release seismic energy in the form of small quakes—but nobody wants to be the first to try the experiment near Los Angeles or San Francisco.

Other seismologists prefer safer investigative tools, such as mathematical

The value of poor building techniques: the sections of Sylmar Veterans Hospital that were too brittle collapsed in 1971.

models, which may answer such questions as when there might be another quake in the Mississippi Valley. This region—now heavily populated—was shaken with great force off and on for a whole year in 1811–12—when almost no one lived there. Also, New Orleans is now sinking fast toward the level of the Gulf of Mexico; models might help tell whether this is an indication of a coming quake.

One of the most exciting clues in the realm of prediction came recently from the Soviet Union, near the small town of Garm in the Republic of Tajikistan. A seismological unit of the Russian National Academy of Sciences has discovered that previous to Garm quakes a conspicuous change seems to occur in the ratio of *P* (sound) waves to *S* (shear) waves produced. In addition, Lynn Sykes and his colleagues at Columbia University's Lamont-Doherty Geological Observatory reported in December that they had discovered the same phenomenon in New York State.

One question that must be asked is, What can a city do even if it is warned? In the unlikely event that a quake could be pinpointed to a specific day, what economic and transportational chaos would result? Worse, what if the quake were predicted for a ninety-day period? Could everyone in San Francisco or Los Angeles retreat to the mountains for three months? If the quake were late, how long should the refugees stay there?

Many scientists would prefer outright prevention of earthquakes, but since this does not seem imminent, others prefer to do what can be done: demand that buildings, reservoirs, freeway overpasses, and other structures be supersafe. "We know where the danger areas are," says Charles Richter, "and which structures in those areas are unsafe and should be removed or rebuilt." Some 1,500 unsafe school buildings in California, for example, are still in daily use. Roughly fifty new housing tracts are constructed each year in fault zones. Builders often repeat the rumor of the man who is responsible for a Daly City development, placed squarely over the San Andreas Fault near San Francisco, saying that he became so guilt-ridden that he refused to set foot in California again for fear that he would set off the quake that would cast his houses into the sea. Because of such disregard for common sense, it is estimated that a repetition of the 1906 quake in San Francisco could claim thousands of lives and cause tens of billions of dollars in damage. Los Angeles, rashly erecting glass high-rises, would suffer at least as much.

The 1971 San Fernando earthquake, thirty miles from Los Angeles, showed,

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as Charles Richter and others have been saying for years, that sound building practices make a difference. The few buildings in the valley that had been built according to earthquake specifications resisted ground movement well; older buildings did not. The Sylmar Veterans' Hospital is a perfect example: more rigid sections fell down, while those with greater elasticity stood.

Ironically, California, popularly known as "earthquake country," does relatively little to protect itself against seismic annihilation. In the decades following the 1906 earthquake local governments muted unfavorable research reports and generally played down the danger in order not to discourage construction and investment. The damage caused by fire in 1906 is publicly played up, almost as though the earthquake had not started it. The state has known the unhappy odds since 1796, when the explorer Gaspar de Portolá watched an earthquake hurl the Santa Ana River out of its channel. Yet there are only poor maps delineating zones of earthquake risk so that buildings can be placed outside of fault zones. Californians have been extraordinarily lucky so far, because their worst quakes have occurred far from cities and at times of day when few people were on the streets.

The state seems to waver uncertainly between apathy and crank predictions. In April 1969 a prescient group known as the Fellowship of the Ancient Mind predicted the ultimate earthquake for the Los Angeles area. A pop song advised: "Where can we go when there's no San Francisco? Better get ready to tie up the boat in Idaho." State Sen. Alfred Alquist, when he was trying to gain approval for his Joint Committee on Seismic Safety in 1969, found that legislators were reluctant to spend money because they thought their districts were far from the San Andreas Fault. Alquist pointed out that no part of his state is immune to quake hazards and paraphrased the New Testament: "Let he who is without faults cast the first stone." One of the country's safest areas was thought to be the East Coast —before the 1886 Charleston quake, which, like the yearlong jolting of the Mississippi Valley in 1811, remains unexplained by seismologists. □

DEATH IN MANAGUA

Nicaragua, the largest country in Central America, is primarily an agricultural region, whose farmers understandably cluster along stretches of rich volcanic soil near Lake Managua. At the south end of the lake lies the capital city of Managua, where more than 300,000 people share a balmy climate, a love for baseball, picture postcard views of the lake, and such nearby volcanoes as Mt. Masaya.

Two days before Christmas another aspect of life in Managua interrupted the gay nighttime *griteria*—the street dancing, parties, and fireworks celebrating the approaching holiday and the local team's success in the twentieth Amateur Baseball World Series. The city rattled and bounced for two hours on December 23 as a series of six seismic tremors struck. Some 75 per cent of the city's buildings were damaged or destroyed, and perhaps 10,000 people died. The three city jails collapsed, crushing eighty prisoners; another 400 took the opportunity to slip away into the night. Lt. Col. José Alagret, commander of the Army Corps of Engineers, said, "This is a city that was, but is no more."

The quake came as no surprise to seismologists—or to Managuans who remembered earlier disasters. The city shook violently in 1885 and again in 1931, when 1,450 people died. Along with some other border regions around the Pacific Ocean, known collectively as the "rim of fire," Nicaragua is one of the most seismically unstable countries in the world. Those who decided to rebuild the capital on the ruins left by the previous quakes did so more on the basis of faith than common sense.

Striking photos taken recently by satellite show why faith was not enough. The city sits along a line of threatening volcanoes. As a result of repeated eruptions, Managua now rests on approximately 300 feet of unstable volcanic rubble—a dangerous foundation for a city of any size in earthquake territory. When the shaking began, this soft cushion settled abruptly and unevenly, as did the city.

The array of volcanoes is no coincidence. Although the gross geology of the region is poorly understood (after the quake the U.S. Geological Survey dispatched a team of three seismologists to study clues derived from aftershocks), the plunging of the Cocos plate (see map) beneath the Caribbean plate seems to be the ultimate cause of both volcanoes and quakes. As oceanic material descends, it is heated by the earth's interior, and some of it rises again toward the surface. As this material pushes against the colder crustal rock, it may break through in the form of volcanoes or cause uneven stretching and settling. Sudden settling of the brittle rock can result in the kind of shallow-focus earthquake that struck in December. Although it would be foolish to rebuild Managua on the site of the old city, there are no really good alternatives in such an unstable zone of the earth's crust. Nicaragua is a country that has no solid place to put its capital.

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Beauty & Her Beasts

BY CHARLOTTE BEYERS

FLO, FIFI, FIGAN, FABEN, AND FLINT: CONSULTANTS TO JANE GOODALL ON THE SUBJECT OF MAN.

The individuals listed above are not members of a law firm or a brokerage house but a family of chimpanzees. With their help British primatologist Jane Goodall has vastly expanded our knowledge of these primates and, in the process, has gained considerable insight into human behavior.

Dr. Jane van Lawick–Goodall fits the image of a female English aristocrat: she is tall, blonde, slender, and ethereal. She is also a *National Geographic* heroine and the wife of a baron. Although socially reserved and shy when addressing an audience, this fragile woman has spent most of the past twelve years in the heart of Tanzania's jungles studying a single troop of chimpanzees.

During those years Dr. Goodall has managed to accumulate a wealth of information on chimpanzee life—thereby acquiring a Ph.D. from Cambridge University—and to establish a research center on the eastern shores of Lake Tanganyika. Anthropologists and ethologists from all over the world visit the center, located in what was the Gombe Stream Preserve (now the Gombe National Park), to learn more about the varied aspects of chimp behavior.

Despite her long years of work and worldwide fame, Goodall still has troubles. Although her achievements have received enormous popular acclaim, she is viewed with suspicion, perhaps out of jealousy, by other primatologists. Her most recent book, *In the Shadow of Man,* was dismissed by some professionals as too "anthropomorphic." Yet there is no doubt that Jane Goodall has added considerably to our knowledge of primate behavior.

Jane Goodall is thirty-eight years old. She spent her childhood in the English coastal town of Bournemouth. "Ever since I was a small child, I wanted to go to Africa," she recalls. "I was fascinated by animals and have always enjoyed being out of doors and living close to nature." She jumped at the chance when a friend in Kenya invited her to visit. While in Nairobi she met Dr. Louis S. B. Leakey, the famous American anthropologist. It was a meeting that literally gave direction to her life.

The late Dr. Leakey must have recognized a kindred spirit. He arranged the initial funding that enabled Goodall to establish her first camp. Looking back, Goodall thinks that Leakey may have sponsored her because he wanted a person with a mind uncluttered and unbiased by theory—a person who would study chimps for no reason other than a real desire for knowledge.

Goodall established her base camp in 1960. "I first went to the Gombe Stream with my mother, because the authorities said they would not have a lone English girl wandering about by herself."

In the first few months the chimps were shy and elusive. "Some days just the sheer joy of being out in the forest would keep me going. But there were certainly days when I was frustrated and despairing. I knew that I would someday make contact with the chimps, but I began to worry that it would take longer than my sponsors were prepared to finance."

"In those days," Goodall recalls, "I felt that the only way to study chimps was to be out in the mountains from dawn to dusk. It didn't matter very much whether I saw the chimps or not; the fact that I was there, without bothering them, undoubtedly sped up the taming process. On a typical day I would have a piece of bread, a cup of coffee from a Thermos, and set out at half past five in order to be up in the mountains by daybreak (around six-thirty). I would try to be near where the chimps had nested for the night."

After they had arisen to feed, Goodall followed them until dusk. At day's end she wearily trudged down the steep mountain trails to her dinner of canned beef, eaten by a small campfire. "After dinner I'd go into my tent and, by the light of a kerosene lantern, would laboriously write out my notes. I couldn't even afford a typewriter in those days.

"I think the discipline involved was frightfully important," she adds. "Looking back, I sometimes wonder whether it was really necessary to work seven days a week, twelve hours a day, dragging myself out even when I felt sick. But I know it was vital to the project,

Charlotte Beyers, a freelance writer, interviewed Jane Goodall at Stanford University.

Photographs by Baron Hugo van Lawick

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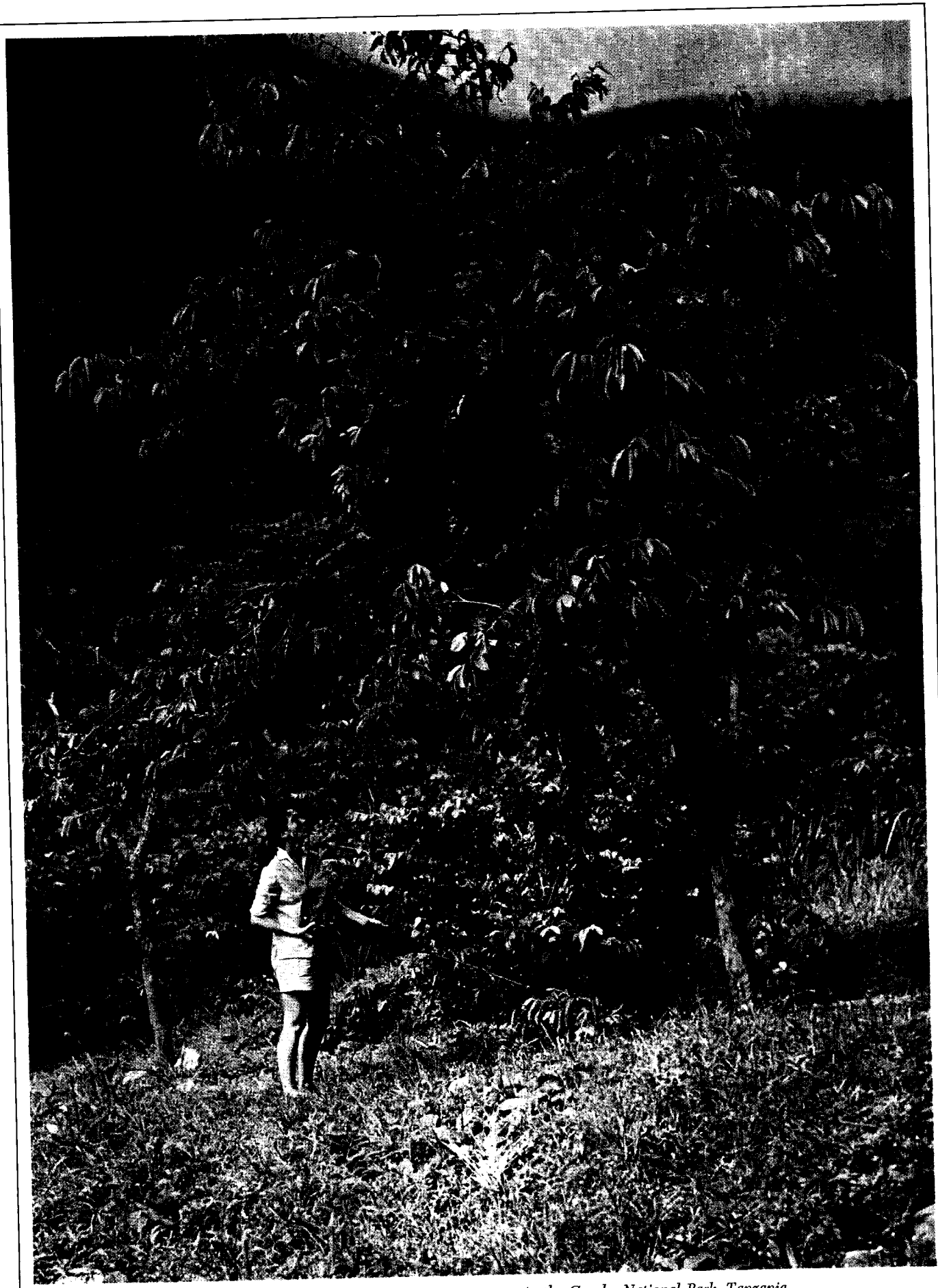

Jane Goodall watching two chimps, or vice versa, in the Gombe National Park, Tanzania.

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"Flo's family is the only one in which I've been able to study the relationship between a grandmother and a grandson." The above photo shows three generations in Flo's family: (left to right) Flo, Fifi (Flo's daughter), baby Freud (Fifi's firstborn), and Flint (one of Flo's sons).

partly because the chimps saw me continually, partly because those tiny, isolated observations added up."

Perhaps it should be noted that chimps, being nomadic, are not easy to observe. They spend their time feeding in trees or roaming around their home territory (which generally covers an area of about thirty square miles). Although chimps live in groups of between thirty and forty individuals, associations are only temporary; individuals meet but seldom stay together.

In 1963, to facilitate her observations, Goodall created an artificial feeding area. She had noticed that chimps are extremely fond of palm nuts; bananas also proved a successful lure for the wary primates.

The first to visit the station was a male chimp that Goodall had named David Greybeard; "I think that the process of habituation would have happened without David Greybeard; he just hastened it tremendously. When I would meet the chimps out in the forest, David wouldn't run away. At first he just sat there; eventually he would come and look for a banana. He was a very calm chimp. He had tremendous qualities of leadership, primarily because he was gentle, and the other chimps would follow him. I think it was his innate calmness that made him accept me when the other chimps were fearful." Soon thirty-eight chimps became frequent visitors, and some would stay for as long as six hours.

While the chimpanzees were in camp, Goodall was able to observe every aspect of their behavior. It soon became apparent that the only stable relationship within the chimp community is that between a mother and her offspring. Goodall began following a female chimp, named Flo, and her progeny. "Flo's family is important in several ways. First, it's an exceptionally large family, which is rare due to disease and a high rate of infant mortality. Secondly, Flo was the first female to become really habituated to me; I've known her right from the beginning. Finally, it is the only family in which I've been able to study the relationship between a grandmother and a grandson, for example. Flo's family has always been very united."

Through her acquaintance with Flo and her progeny—Fifi (female) and Figan, Faben, and Flint (males)—Goodall was able to gain a great deal of insight into the child-rearing methods of chimpanzees. "A chimp doesn't normally leave his mother until about eight years of age. I think the period of dependence is significant, particularly in relation to man. Like a human, a chimp has a tremendous amount to learn. He has to know how to react to different individuals; he has to learn tool-using techniques and hunting techniques—where various foods are at different times of the year." With his mother there to protect him, a young chimp can devote his energy to exploring his environment and acquiring the skills needed for adulthood.

Goodall admires the manner in which chimpanzee mothers maintain close contact with their offspring and the tremendous patience they show toward them. "Fifi tried for two months to take Flint away from Flo when he was tiny, and Flo very gently dissuaded her. Flo never lost her temper; she never hit Fifi. Flo would either move away or distract Fifi by playing with her or grooming her. The technique of distraction is something I have found extremely useful with my own son."

The relationship between a female chimp and her progeny is a close one. "I would strongly suspect that the kind of affection between a chimp mother and her offspring and a human mother and her children is very, very similar. The motivation to protect, to nurture, and to suckle is very close in both species. Flint's grief at his mother's death, for example, underscores this point."

Flint had been with his mother when she died while crossing a stream. For three days after her death Flint returned to the body and tried to extricate maggots from the corpse. Within a week following the death of his mother Flint became so lethargic and depressed that he lost a third of his weight. He exhibited all the signs we associate with severe depression; he refused to eat and would sit huddled up in a ball.

"On the fifth day Flint met his sister, Fifi, and it seemed as if her presence helped him relax. When she moved away, we were sure that Flint would follow. Although Fifi waited patiently, Flint lay down under a bush. During the last two weeks of his life he hardly moved at all.

"The day before he died, he returned to the place in the stream where his mother had been. He spent a long time looking at the rock on which she had lain before he moved away."

Although it is clear that Goodall is exceptionally interested in the child-rearing behavior of chimpanzees, through her years of observation she has amassed material on other aspects of their behavior as well. "I think that a lot of notions about chimpanzees were changed as a result of my observations. Their tool-using and -making capabilities have turned out to be very much greater than anyone had originally supposed. The social structure of chimp communities is also quite different and much more complex than we had expected. It was a great surprise to people that chimpanzees hunt and eat medium-sized mammals and that they show cooperative behavior when they do so. But I think my most important discoveries are the similarities between chimpanzees and humans—similarities in posture and gestures and in the length of dependence on, and duration of bonds between, family members."

Goodall also finds parallels between chimpanzee adolescents and American male teen-agers. "In both cases," she

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remarks, "the male becomes unsure of himself as he tries to enter the adult community. The chimp male, like his human counterpart, endures a turbulent period during which he becomes more openly aggressive to females and more cautious about interacting with adult males." And adolescents of both species spend a lot of time and energy trying to impress their peers.

Unlike the human female, who is sexually receptive all the time, a female chimp is sexually aroused only ten days of each month, provided that she is neither pregnant nor lactating. Yet, Goodall adds, "it is very interesting to speculate on what would happen if a chimp were in estrus all the time." As it is, when a female is in estrus, a male may force her to establish what Goodall terms a "consort relation." They leave the group for the duration of the estrus cycle but usually return singly when the cycle is over. "I tend to believe that the consort relationship in chimps may be a very shadowy forerunner to the kinds of relationships that can develop between human adult males and females. But then again," she qualifies, "the relationship that typifies human love in its truest form is, of course, dependent on the development of language and simply can't be compared with that of chimps."

In the area of aggression, Goodall feels that the similarities between the two species lie in their use of bluffing techniques. "There's a certain element of swaggering involved. Like a chimp, a man will wave a stick or his arms about when he's threatening someone." But, unlike humans, chimps rarely hurt each other.

There was, however, one incident of cannibalism reported by a researcher at a center. A female, apparently, a stranger to Goodall's chimpanzees, was severely attacked and driven off. Subsequently an infant, presumably hers, was killed and partially eaten.

"Our first thought was that the sight of blood drawn during the fight with the female set off a predation response. But this does not explain why Humphrey continued to kill the infant as it screamed."

Sounding disturbed and ashamed, Goodall continues: "The infant took about ten minutes to die. They killed it by eating it. Once the infant was dead, only one leg was eaten. Yes, these were our own chimps: Figan, Humphrey, and Mike."

According to Goodall, "We have a lot to learn from primates, particularly in the area of child rearing. I think there are a lot of things wrong with today's society that are a direct result of poor child rearing. I am not necessarily saying that we should do as chimps do. But we certainly have room for improvement. In the case of orphans a mother substitute would suffice as long as she behaves in the right kind of way. There was an experiment done in England in which little, unwanted orphans were put with old people, and the results were most superb. The old people came to life, and the children were loved and wanted."

"Chimp gestures are very close to human ones. They kiss each other, hold hands, and pat each other on the back. Excited chimps, when they see a beautiful pile of food, for example, tend to fling their arms around each other's necks and scream. When peace was declared in England, I remember streets full of people doing exactly the same thing—they were laughing, crying, and hugging one another. I believe the same kind of emotion underlies these gestures in both species."

"While young, chimp siblings play together, fight, and generally behave in exactly the same fashion as human children."

Much has changed for Jane Goodall since those days in the early 1960s. In 1961 she met the Baron Hugo van Lawick, a young Dutch photographer who traveled to the Gombe Stream to photograph Goodall and her chimps. They married in 1964, and three years later Jane gave birth to a son, Hugo Junior, nicknamed and always referred to as "Grub."

Public acclaim has brought Jane Goodall many new problems. She is no longer free to roam the forests for days on end following her beloved chimps. In 1971 Goodall began a new career as visiting professor in the Department of Psychiatry at Stanford University. Her present responsibilities include a full schedule of public appearances, lectures, and teaching. In addition, she has administrative duties as Scientific Director of the Gombe Stream Research Center.

"A day at the Gombe is now totally and utterly different than it used to be. After all, I have a child there now, and I feel that it is more important to give time to my child than to the chimps. It is hard. When Hugo was at the Gombe last year, we would have breakfast and lunch together, have dinner with all the students, then go back to the house to read or talk. I'd spend the afternoon with Grub, walking with him on the beach, swimming, or looking at birds and insects with him." Her voice warms when she speaks of her husband's support. "He helps with the administration and works out systems of accounting and coping with labor. He plays an incredibly major role," she says loyally.

Looking at this intensely feminine woman, who is admittedly no advocate of the women's liberation movement, one wonders if she might have preferred to remain undiscovered. □

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THE NEW GHETTO HUSTLE

BY TABITHA M. POWLEDGE

Robert Clark, the only black in the Mississippi House of Representatives, came home from a Chicago conference of black legislators a year ago determined to do something about an inherited disease that occurs in about one in 500 of his people—sickle-cell anemia.

He and his staff researched the subject and proposed a bill—similar to one that had gone into law in Massachusetts—that requires testing children for sickle-cell at the time they enter school. The bill passed unopposed.

Now Clark is under fire from an unexpected quarter—the people he was trying to help. "People in my district were saying that I went and passed a law against black folk," he says, "but I was trying to do what's right. If the law's not doing what it's supposed to do, I want to help. Let's change it." His staff is now researching an amendment that will be presented to the legislature shortly.

Without knowing it, Clark and a number of other legislators have become victims of what may be the newest medical phenomenon: the political disease. Sickle-cell is among the first, but others are sure to emerge.

An important, but little-noticed, by-product of increasing public awareness of sickle-cell anemia has been a proliferation of state laws concerning screening for it. Several such laws were on the books before some of their pernicious implications became clear. Some of them make testing compulsory. Some are biologically absurd; for instance, in Washington, D. C., sickle-cell is legally a communicable disease. In several states blacks must be tested for it, along with venereal disease, before they can marry.

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STEVEN OSBORN

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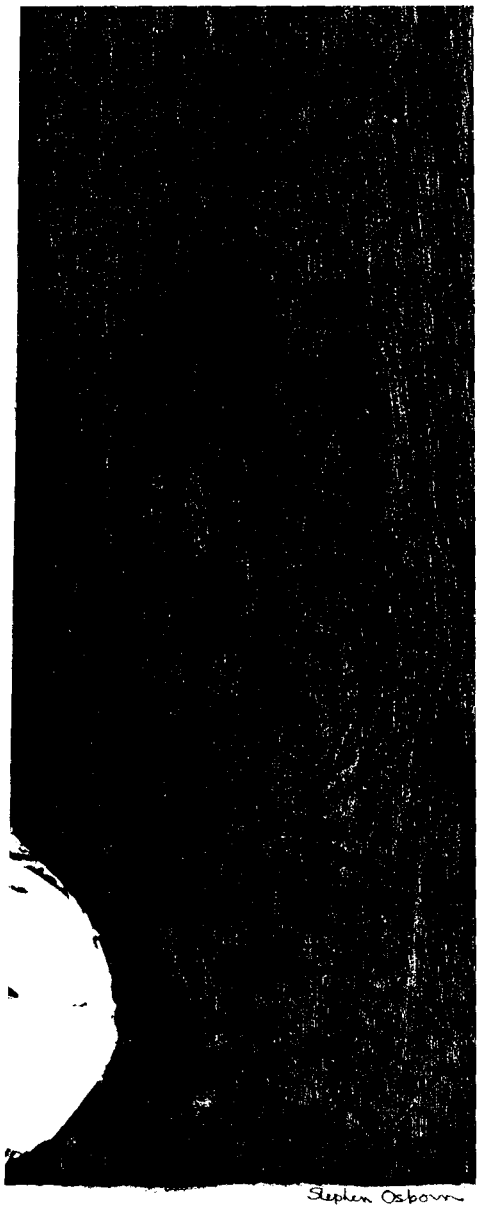

WELL-INTENTIONED GENETIC-SCREENING LAWS FOR SICKLE-CELL ANEMIA ARE UNEXPECTEDLY BACKFIRING.

Some of the more impassioned critics charge that such screening laws are an attempt at genocide. On the other hand, a doctor who has worked on the disease for years retorts that it is more a matter of "genosave." But judging from a recent study in which more than half the blacks interviewed expressed fear that whites were out to reduce the black population by birth-control measures, it is not surprising that laws that single out a disease restricted almost exclusively to one racial group are viewed with suspicion.

Considering that most of the laws that provide sickle-cell testing have been sponsored by black legislators and prompted by black groups, the genocide charge seems somewhat improbable. "A lot of people said if the white legislature voted for it unanimously, then it had to be bad," says Clark. "I just didn't see it like that."

Much of the motivation for sickle-cell screening has unquestionably been decent, but it has been obscured by a Republican administration's desire to make some inroads on the black vote. As a result, a great deal of money—as much as $115 million in the next three years—will be available for research and treatment. This is, of course, very gratifying to those who have been doing research on the disease with virtually no support for many years. Nonetheless, at a meeting of black social workers last spring, the sickle-cell workshop was entitled, "The New Ghetto Hustle."

Sickle-cell anemia is known in genetics as an autosomal recessive; that is, it takes *two* sickling genes—one from each parent—to give a child the disease. A person with just one sickling gene (and one normal gene) does not have the disease. But because he possesses a single defective gene, which can be passed on to his children, he is said to be a carrier of sickle-cell trait. Carriers occasionally are affected by symptoms of sickle disease at high altitude or in unpressurized airplanes, but usually the only risk is that they will marry another carrier and run a one-in-four chance that each pregnancy will result in a child with a full-blown case of sickle-cell anemia. Until recently that was a terrible chance—the disease is commonly lethal before adulthood.

Sickle-cell anemia is caused by a defect in one of the genes that regulate the manufacture of hemoglobin, the substance in red blood cells that binds and carries oxygen to the tissues. People who have the defective gene produce sickle hemoglobin rather than "normal" hemoglobin, and this causes the red corpuscles to assume a sickled shape, rather than their usual doughnut shape when little oxygen is available. Once sickled, the cells do not glide smoothly through capillaries. Instead they jam up, preventing vital substances, including oxygen, from nourishing tissues.

Known as a sickle-cell crisis, this capillary blockage is excruciatingly painful. The disease also causes other difficulties, including slowed growth and development and increased susceptibility to infectious diseases. Most of those affected by the disease die young, often before twenty. Few live past forty. There is no cure, and there won't be one until scientists learn how to manipulate genes. This is way beyond them at the moment. Treatment consists by and large of attempting to relieve the pain of crises and to control frequent infections with antibiotics. Nobody pretends that the existing methods are entirely satisfactory. A method of desickling the cells, using urea, and another to protect cells from sickling, using cyanate, are being tested, but it will be months before we know for certain if they are more than promising. Nevertheless, because of improved levels of medical care in general, many sickle-cell children survive until their late teens and occasionally longer. However, there is no way of telling in advance who will get the most benefit from treatment.

For a black couple with the trait, the prospect of pregnancy can be chilling. Their choices are sharply defined and equally devastating: either take a 25 per cent risk that each pregnancy will produce a child affected by sickle disease or remain barren. (Adoption, or even artificial insemination with a non-sickle-trait donor, is, of course, possible.) Although there is no way, as yet, to detect sickle-cell disease or trait before birth, researchers at Children's Hospital Medical Center in Boston have come up with a test that holds potential promise. There is, however, a serious technical difficulty: fetal blood is needed for the test, and no safe way yet exists to obtain it (the researchers did their initial tests on blood obtained from aborted fetuses). Several novel methods of taking a fetal blood sample are currently being investigated. Even if one is proven safe, there are many professionals who question its wisdom; they prefer to concentrate their energies on improving treatment. If adequate treatment becomes available, they say, there will be no reason to do the test or, going one step further, to counsel the parents that they can choose to have an abortion (should the test in question prove positive) and try again. Says Dr. Robert F. Murray, Jr., chief of the medical genetics unit at Howard University, "If you don't emphasize treatment as much as or more than prenatal diagnosis, then some of people's fears about genocide are justified."

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THERE IS SOMETHING PARTICULARLY DREADFUL ABOUT BEING TOLD THAT YOU ARE A CARRIER OF A GENETIC DISEASE.

It is problems like these that have made discussion of the disease such a prickly subject and led to the charges of genocide. People in Mississippi told Clark that it was "like Tuskegee"—a reference to the now infamous government study of venereal disease, in which black men with syphilis were deliberately not treated. "White people," some said to Clark, "are taking over the genetics of black people."

Blacks can hardly be blamed if they are somewhat cynical and suspicious about this sudden white interest in their disease. Just two years ago Dr. Robert Scott of Virginia Commonwealth University reported in the *Journal of the American Medical Association* that sickle-cell anemia was receiving fewer National Institutes of Health research grants than were many less-common hereditary diseases. And in 1968 volunteer organizations that raised more than $7 million for muscular dystrophy and almost $2 million for cystic fibrosis added only an estimated $50,000 for sickle-cell research. This fiscal year $25 million in federal funds may be available.

There is wide agreement that President Nixon was the spearhead of this drive. He singled out the disease for special mention in his February 1971 health message and asked for a $5-million increase (sickle-cell funding was at about the $1-million level at the time) in federal spending in fiscal 1972. Congress responded rather more enthusiastically than the President had intended, passing the National Sickle-Cell Anemia Control Act, which he signed last May. This authorizes $115 million for screening, counseling, information, research, and treatment over the next three years. The operative word is *authorizes*: no money has yet been appropriated. But sickle-cell suddenly became well known. It is no longer a neglected disease.

In some ways, to say that sickle-cell has been a neglected disease is totally false. The model of the disease that has emerged from research since the 1940s represents a brilliant fusion of medicine, molecular biology, and anthropology. Hemoglobin, the part of a red blood cell involved in oxygen transport, consists of two parts, heme and globin. Globin is a fairly uncomplicated protein composed of four chains of hundreds of amino acids. Sickle globin differs from normal in just one amino acid. Thus, the disease exists because the molecule is not built quite right. Linus Pauling, two-time Nobel laureate, made this discovery in 1949, coining in the process the term "molecular disease."

A gene that causes a lethal disease, such as the sickle gene, should be rare, according to genetic dogma, but it is actually rather common. In some places in Africa as much as 35 per cent of the people are carriers. In this country almost 10 per cent of American blacks are thought to be carriers, and about 50,000 people have two sickle genes and thus the disease. Genetic dogma also has it that when a condition so lethal is also so common, it must offer some special advantage. As early as 1949 it was suggested that the advantage might be protection against malaria. In the last two decades a number of workers have demonstrated the likelihood of this fascinating hypothesis. It is now widely accepted that possession of one sickle hemoglobin gene, in a way not yet fully understood, confers protection against this mosquito-borne disease. Thus, one in four children of carrier-carrier marriages in Africa or other malarial areas may die of sickle-cell anemia, and one in four (with "normal" hemoglobin) may die of malaria, but half the children of such marriages will be carriers who will probably succumb to neither disease.

A trait that is highly adaptive in Africa, however, may be worse than useless in the predominantly black Bedford-Stuyvesant section of Brooklyn. Although sickle-cell is now enshrined in textbooks as a classic example of molecular research and Darwinian fitness, the fact remains that there really is no very good treatment for the disease, and that is where the charges of neglect begin. Dr. Rudolph Jackson, head of the Sickle-Cell Disease Branch of the National Heart and Lung Institute (which is charged with carrying out the provisions of the new sickle-control act), said the disease was indeed neglected prior to 1971.

The sudden burgeoning of interest in sickle disease is the result of a convergence of three factors: charges of neglect, an infusion of money, and a ripening technology. Diagnostic technique has also made its contribution. Inexpensive, relatively easy mass-testing procedures are available that can reliably reveal the presence of abnormal hemoglobin in a small blood sample. The tests detect both the trait and the disease.

A number of states have recently passed laws making such tests available on a voluntary basis. In a few states, however, they are compulsory. Only twenty-two states have no sickle-cell laws. The laws that disturb some people are those providing for compulsory testing. The federal law is firmly voluntary, and it seems likely that any state hoping for a piece of the promised Washington pie will have to have a voluntary law.

Some of the laws also contain a good deal of medical nonsense. The Massachusetts law is a case in point. It requires testing of all children before or during the first year of public school. It would be difficult to find a doctor who would endorse testing a child of this age. If the purpose of the screening is to find sickle-cell disease, it is probably too late. Almost all children with the disease have undergone crises and have been diagnosed long before this. If the purpose of the screening is to find carriers and offer them genetic counseling, it is far too early. A child of seven who happens to

(*Continued on page* 45)

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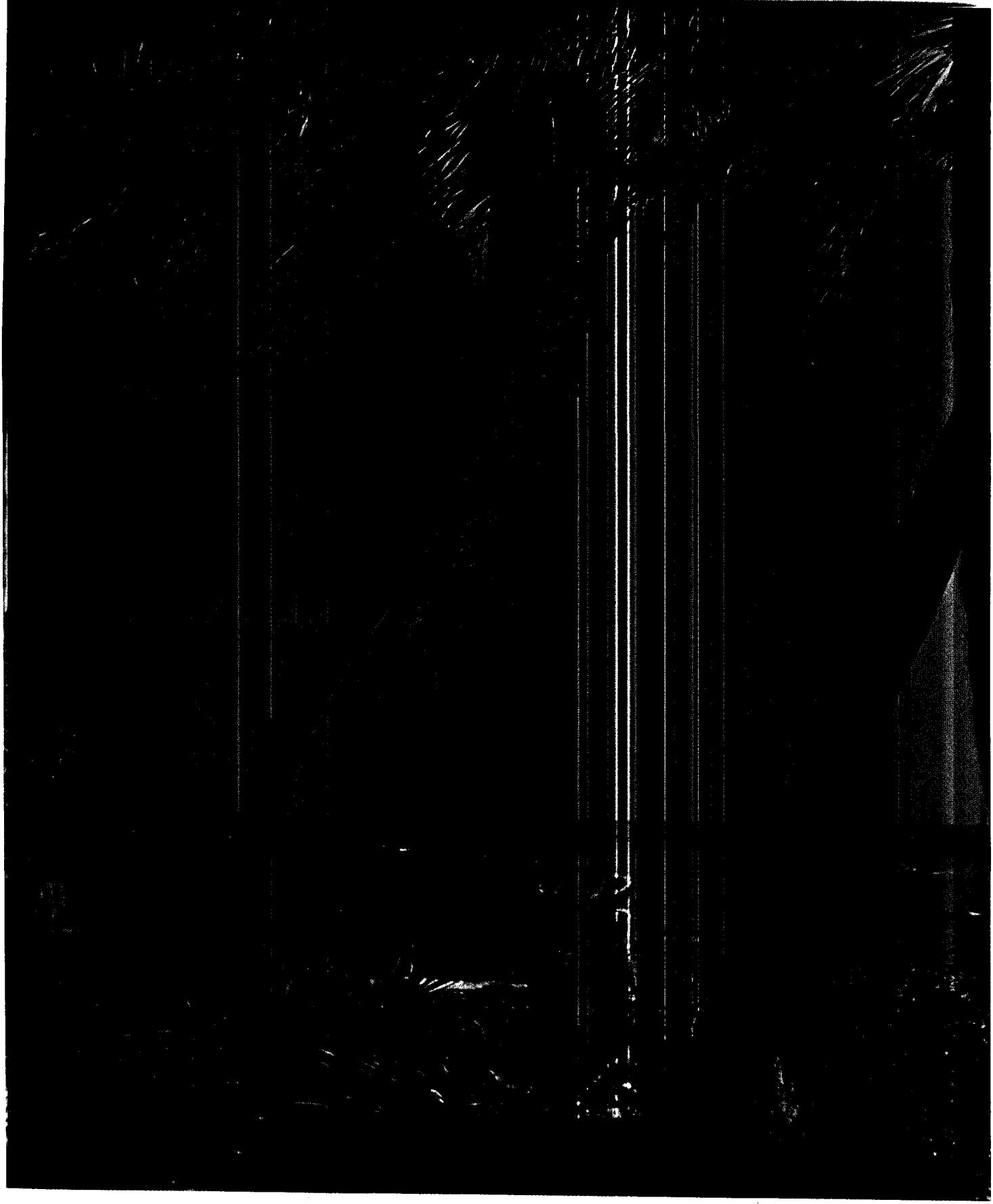

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MARRIAGE-LICENSE LAWS WITH GENETIC-SCREENING PROVISIONS REPRESENT THE OPENING WEDGE FOR GOVERNMENT INVOLVEMENT IN GENETIC CRITERIA FOR PROCREATION.

be a carrier should not be expected to deal with the notion that he might give his future children a fatal disease unless he selects a marriage partner who is not a carrier. About the only advantage of testing in this age group is that it is easy. Children entering the public school system for the first time generally undergo a medical exam anyway—screening means performing just one more test on this captive population.

The Massachusetts law, which was approved July 1, 1971, has never been enforced. In fact, the state health commissioner, Dr. William J. Bicknell, has been instrumental in proposing a substitute piece of legislation. It provides for voluntary screening for sickle-cell and three other genetic diseases and gives the commissioner flexibility in determining what other diseases should be added to the list and when and how screening should be done. This ought to make it possible to keep pace with the technical advances that are sure to come. Besides screening, the new proposal calls for appropriate counseling and treatment, as well as strict confidentiality with respect to medical records.

The largest group of genetic-screening laws requires sickle testing before marriage. These nearly always are amendments to the regulations requiring tests for venereal disease. There is some question about whether it is psychologically desirable to couple venereal and genetic disease, and there is also some argument about whether this testing, for carrier status, is not too late, since the man and woman have already made the decision to marry. As with children beginning school, the legislators again have selected a captive testing group, one that is already having blood drawn for another purpose. And it can be further argued that the genetic-screening provision of the marriage-license laws represents the opening wedge for governmental involvement in genetic criteria for procreation.

"The ideal timing for testing programs has not been determined," says Dr. Howard A. Pearson, director of the division of pediatric hematology at Yale. "If the aim of testing is to provide carriers of the sickle-cell trait with information applicable to marriage, testing in infancy or early childhood may be too early. The teens would seem to be a particularly advantageous age. A junior or senior high school student is usually receptive to a sickle-cell educational program when he learns that the results may have personal relevance; he also is accessible for testing and counseling. A number of programs designed for teen-agers have been well received." Since high school students are as captive a group as the others, it is surprising that no state law has focused on this age group. Additionally, teen-age students could be taught about human diseases in genetics sections of their biology courses.

Some doctors—particularly pediatricians—favor testing of the newborn because of a slight advantage in early detection of sickle-cell disease. Georgia's compulsory genetic-screening law specifies newborns (it is Julian Bond's only piece of legislation to date, and it, too, was passed unanimously but is not being enforced). Other doctors see little value in testing infants, especially since the disease itself is not preventable and knowledge of carrier status can be actively harmful.

This question of being a carrier is a central issue in genetic disease. There is something particularly dreadful about being told that you are a carrier of disease, and it is becoming increasingly clear that the implications are more than just psychological. In addition to whatever is being done under law, there are private groups providing sickle-cell screening, and few of these have the money or personnel for the intensive counseling that should accompany any screening program. As a result, people who have sickle-cell trait often become confused, and some wrongly believe that they have the disease, despite the fact that most carriers have no symptoms whatever. This confusion was written into the original Massachusetts law, which refers to "the disease known as sickle-cell trait or sickle-cell anemia." Granted that the medical terminology is awkward—"trait" is synonymous with "carrier"; "anemia" is synonymous with "disease"—the law should be patently lucid in this respect, if in nothing else.

With confusing and sometimes badly planned laws, instances of higher life-insurance premiums, and reports of job discrimination, it is no wonder the carrier begins to think of himself as something less than hale and hearty. Dock Ellis, a pitcher for the Pittsburgh Pirates, in testimony a year ago before a Senate subcommittee, blamed his poor pitching record in part on sickle-cell trait. When he was seventeen, a doctor had told him he had sickle-cell anemia. After he signed his baseball contract, a physical examination revealed that he was actually only a carrier. "I have a chronic arm problem," he said. "I don't know if it can be caused by sickle-cell anemia." The thought that his physical problem was somehow related to a genetic condition—though most doctors would find that unlikely—was no doubt unsettling.

Carrier status can not only be psychologically harmful to the carrier and his family; it can sometimes be more than that, too. There is on record the case of a child's dying because his physician, having been told by the child's mother that the child had sickle-cell anemia, thought he was witnessing a sickle crisis. Actually, the child had the trait, not the disease, and what the doctor was witnessing was acute appendicitis.

This confusion between the trait and the disease is widespread, and the only cure for it is detailed and sometimes repeated counseling, which is expensive and not readily available. Many of the state laws do not provide such counseling, probably because the majority of legislators prefer to attack problems

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in less expensive ways—and the screening procedures alone are relatively inexpensive. Gary J. Clarke, a member of the Eagleton Institute of Politics at Rutgers, who has helped draft a number of the sickle-screening laws, says, "Most of the sickle-cell programs established by law are inexpensive means of starting to get at a long-ignored problem. Even the most conservative and perhaps bigoted legislator can feel comfortable about approving a sickle-cell bill as a 'health' measure, whereas he would never approve of welfare or public-housing programs, because they are 'economic' measures."

Genetic screening, in general, is still relatively new, but already some thorny problems have arisen. For instance, a majority of the states now have laws requiring screening of all newborns for an inherited disease called phenylketonuria (PKU). It is a very rare metabolic disorder—one in 10,000 births at most—that results in severe mental retardation. A special diet instituted in early infancy has been thought to prevent the worst symptoms, so there was a flurry of screening legislation in the early 1960s designed to detect those who need the diet. In just eighteen months thirty states passed PKU screening laws. This was probably the archetype of the political disease. The last time Nelson Rockefeller ran for governor of New York, one of his television commercials stressed his support of the New York PKU bill—the implication being that Rockefeller was single-handedly wiping out mental retardation. In fact, PKU is responsible for comparatively few cases of mental retardation. Furthermore, doctors are now beginning to question the effectiveness of the diet and the cost of the screening compared with its results. Cost-benefit analysis seems like a hard-hearted way of dealing with such a problem, but it is a legitimate way to put it into perspective. Spending the same amount of money to discourage childbearing in women who are past age thirty-five almost certainly would have a much greater impact on decreasing the number of mentally retarded children than would detecting and treating all the potential PKU victims.

The Sickle Tests

The diagnosis of sickle-cell trait and sickle-cell anemia relies on a sample of blood taken either from a vein in the arm or from a pin-prick-size hole in the fingertip. Though there are three major classes of tests for determining the presence or absence of abnormal sickle hemoglobin, not each of them gives uniformly accurate genetic information.

Most authorities agree that the most reliable test is electrophoresis. This test is done by passing a small amount of hemoglobin, derived from the blood sample, through an electric field. Because hemoglobin molecules are negatively charged, they move toward the positive pole of the field. This field is actually an inert substance in which the hemoglobin is suspended.

Not all the hemoglobin ends up at the same position, near the positive pole. Different kinds of hemoglobin—and there are many variants, only a few of which, like sickle-type, cause disease—have negative charges of differing strengths. Thus, some will move across the electrophoretic field more rapidly than do others. As a result, the spot where the migrating hemoglobin ends acts as a marker for a specific variant of hemoglobin. This end position represents a sort of electric fingerprint for a particular hemoglobin. In any one sample of blood there may be several types of hemoglobin, all identifiable by the way their electrophoretic end points are related to each other. This makes it possible to distinguish among the various kinds of hemoglobin. It also makes it relatively easy to tell a carrier of sickle hemoglobin, who will have both normal hemoglobin and sickle hemoglobin, from someone with sickle-cell anemia, who will have only sickle hemoglobin. This test is very precise and gives few erroneous results. However, should the result be wrong, it would likely be a false negative—indicating that the blood sample tested was free of sickle hemoglobin when in actuality it was not. One drawback to electrophoresis has been that it was often fairly expensive, because it required trained personnel to operate costly machinery. A new version, using less expensive cellulose acetate strips (similar to the backing material of ordinary photographic film) as a medium through which the hemoglobin migrates and less complicated equipment, has been refined to the point where a technician can do as many as 150 blood tests a day, at a cost of about a nickel each for materials.

A second sickle-testing method requires the addition of a reducing or deoxidizing agent to blood and the interpretation of what happens to the combination under the microscope. The reducing agent will deprive the blood sample of oxygen and, if the sickle condition is present, the individual red blood cells in the sample will each attain a crescent (or sickle) shape, visible under high magnification. Widely used for years, this test—commonly called sickle prep (for preparation)—is unable to distinguish clearly and consistently between blood from people with sickle-cell trait and those with the anemia, nor does it detect other abnormal disease-producing hemoglobins that do not cause blood cells to sickle under reducing conditions. For these reasons the test is gradually losing popularity.

Most of the mass-screening procedures rely on various solubility tests. A solution containing a mixture of phosphate buffers, dithionate, and saponin will turn cloudy in the presence of sickle hemoglobin, which is less soluble than normal hemoglobin. A prepackaged, trademarked version, called Sickledex, costs about 50 cents per test and can be administered by virtually anyone. The same results, however, can be accomplished for as little as 2 cents each with any of several recently described methods that utilize the same chemicals as does Sickledex but require mixing in the correct proportions rather than using a prepared package. The solubility tests can even be automated: a recent report said that such a test could process 960 blood specimens in eight hours. Unfortunately, a "positive" solubility test means only that there is an abnormal hemoglobin present; like sickle prep, the test does not distinguish between the carrier and the person with the disease, nor between sickle hemoglobin and other variants. Since some versions of these solubility tests need almost no training to administer, they have sometimes been used in screening programs not connected with medical facilities and therefore not equipped to follow up with help for those who test positive.

In mass-screening programs that are adequately devised, the usual procedure is a solubility test followed by electrophoresis on the blood of those individuals with positive solubility results. This should determine the exact nature of the abnormality and should also help insure that people get proper treatment and counseling.

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The same questions have arisen in sickle-cell. It has been forcefully argued that money that is spent on sickle-cell programs would be more effectively used for prevention of lead poisoning or treatment of conventional iron-deficiency anemia, both of which are much more widespread health problems in the black community than sickle-cell. However, as Gary Clarke observes, "I may personally feel that there are ten problems more important to the black community than sickle-cell anemia, but if I cannot get agreement on those first ten problems, should I ignore the eleventh problem, on which I *can* get agreement? Especially when I realize that public funds will be used for some other purpose if I do not lay claim to them for the community I am interested in helping?" That may be the essential impetus behind the bills: we screen because we have the techniques and the money. Until recently no one looked beyond these facts to determine if there were any benefits.

Doctors seem to think that there are some health advantages to screening, and even those who are most critical of the laws advocate changing them rather than repealing them outright. They are understandably reluctant to discourage the first serious interest shown in this disease and are hopeful that one by-product will be increased consciousness of black health problems in general, by both blacks and whites.

Some sickle-screening critics question whether the laws are constitutional, particularly those that make screening compulsory. Harold Green, professor of law at George Washington University, who has studied the issue, points out that screening for venereal disease and tuberculosis, among others, has been held to be constitutional even when compulsory, on grounds of possible danger to the public health. The situation for genetic illnesses, which are not communicable in the usual sense, is rather different and has apparently never been tested in the courts. The District of Columbia, however, provides for sickle-cell screening under its regulations governing infectious disease. Green believes that the current laws probably are constitutional but that they may be vulnerable on the grounds that legislation drawn along racial lines is "inherently suspect."

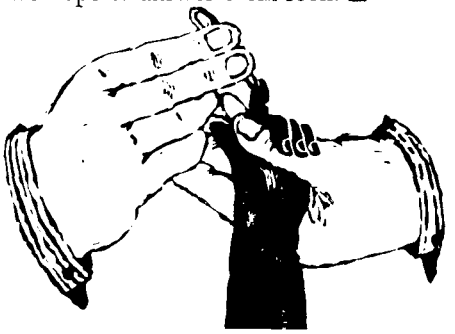
To get around the delicate question of race, some of the laws rise to startling heights of doublethink. It is a fact of medical life that genetic disease, being inherited, is frequently confined largely to a particular group of people. Thus, PKU and cystic fibrosis are "white" diseases, Cooley's anemia is Mediterranean (mostly Italian), and Tay-Sachs is found in Jews whose forebears came from Eastern Europe. Clearly, it is a waste of time and money to screen the whole population for a disease confined almost exclusively to one segment of it, even in the name of democracy. Legislators, however, were unable to bring themselves to use the word *black* or even *Negro* in the sickle-cell laws.

New York provides two of the best examples of clumsy attempts to deal with the problem. The state has two laws, one requiring screening before school entry and another specifying premarital testing. The school-entry law mandates the testing of "city" school children. That alone is ridiculous enough, but the absurdity is compounded by the fact that Buffalo, Rochester, and New York City (with the three largest black populations in the state) are probably exempt from the law because of complicated home-rule provisions. On the other hand, the marriage-license law specifies the testing of "each applicant for a marriage license who is not of the Caucasian, Indian, or Oriental race." The law also specifies that the test is "for the purpose of discovering the existence of sickle-cell anemia." That is another example of biological nonsense—it would be quite extraordinary for someone with the disease to arrive at marriageable age without knowing he had it.

Legislators in other states have not gone to quite these illogical extremes. But instead of accepting the responsibility for racial classification, they have shifted the decision as to who should be screened to the state health commissioner or the examining doctor or even the marriage license clerk. And yet some legislation designed specifically for one or another racial group has been held constitutional. It is difficult to understand why an objection arises to saying that something is largely a disease of blacks or whites or Italians when it in fact is, particularly when the group in question is sponsoring and backing the legislation.

Dr. Charles Whitten, a professor of pediatrics at Wayne State University in Detroit and president of the National Association for Sickle Cell Disease, Inc. (a Los Angeles–based umbrella organization, covering many smaller, local sickle-cell groups), prefers that legislators "seek assistance from those who have had experience" when they write their genetic-screening laws. But where were the doctors and other health professionals when the laws for sickle-cell and PKU were being written?

These two genetic-screening programs are just the beginning. President Nixon last summer signed a bill authorizing the spending of more than $11 million in the next three years on Cooley's anemia—known medically as thalassemia. There already have been highly successful pilot programs to screen Jews for carriers of Tay-Sachs disease. Both of these diseases are mentioned in a screening bill pending in New Jersey, which also gives the health commissioner of that state discretion to add other diseases to the list. The new Massachusetts bill has similar provisions. In Maryland the senator who sponsored that state's sickle-cell bill has formed a committee to look into other genetic diseases. Regardless of backgrounds, many, if not all, of us and our children will be targets of one or another genetic-screening program in the not-too-distant future. There are important questions to decide. Who should have access to our genetic information? Will genetic screening provide legal precedent for other kinds of screening—for instance, psychological? Are we willing to spend enough to provide the education and counseling that are so crucial in understanding the nature of genetic disease? Do we *want* to start setting genetic standards for having children and, what's more, involve the government in those standards? We ought to begin thinking about these questions now if we hope to answer them soon. □



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MAN'S HUMANITY

BY BRUCE WALLACE

"At what stage in the alteration of his product will the genetic engineer no longer regard it as human, as a member of mankind?" the undergraduate religion major asked. Still numb after a twenty-hour, all-night bus ride, I could only sympathize with Darwin's wistful comment: "I have no great quickness of apprehension or wit which is so remarkable in some clever men . . . ." Because my earlier discussions with this student had revolved about the possible abuse of genetic engineering by its practitioners, my answer took the same easy route: Let us not worry unnecessarily about what molecular geneticists might do.

First, the necessary techniques for manipulating specific genes within individual germ cells have not been developed. Second, although the ability to make human-ape hybrid crosses has existed for many years, it has not been exercised. The technology that enables the farmer to breed cattle, pigs, and other animals by artificial insemination has simultaneously made gorilla-man and chimpanzee-man hybrids possible. Because lion-tiger, horse-ass, and dog-wolf crosses are successful, I suspect that man-ape crosses might also succeed. Nevertheless, as far as I know, such crosses have never been attempted. Hence, we can at least acknowledge that the problem of spawning nonhuman human beings has been with us for a considerable time; modern geneticists with their new and elegant experimental techniques are not confronting us with brand new problems.

The answer that I put together in response to the student's question is all right as far as it goes. On reflection, however, I realized that it did not go far enough and that the original question remained largely unanswered.

Can biologists manipulate genetic material so that individuals of one species are forced—literally *forced*—to produce offspring that must be classified as a different species? Yes, they can; we must, however, first clearly understand the meaning of the word *species*.

There are at least two kinds of species in biology: species of convenience and "biological" species. Species of convenience are taxonomic species; they represent pigeonholes that aid in the orderly classification of plants and animals. There may be no break in the entire fossil record of a particular kind of organism; nevertheless, if its members evolved steadily with time, students will label individuals of different time periods with different names. The naming is done simply as an aid to communication. Each name refers to organisms possessing certain characteristics; that the characteristics blend imperceptibly with those of individuals living at earlier and later times is of no importance to the classifier.

A biological species, on the contrary, is not necessarily a category of convenience; indeed, taxonomists often find biological species grossly inconvenient. These are species that do not interbreed extensively in nature even though they have ample opportunity to do so. To recognize members of different biological species is at times extremely difficult. Although virtually identical, individuals may belong to sharply isolated breeding groups.

At least twice in the past half-century geneticists have taken time to manipulate the chromosomes of the vinegar fly (*Drosophila melanogaster*) so that the altered strains are reproductively isolated from the original wild-type strain but fertile when crossed with one another. Unofficially, these strains can be dubbed *Drosophila artificialis*. In all physical and chemical respects the flies of the artificial species are as much like wild-type *melanogaster* as members of the latter are like one another. Therefore, on the basis of any physical test *artificialis* and *melanogaster* do not differ. They do not represent different *species of convenience*. On the other hand, they are reproductively isolated, with no reasonable chance that the cause of isolation (complex chromosomal rearrangements, induced by X-ray exposure) will ever be remedied. Hence, they may legitimately be given separate species names, provided that someone is willing to write the species description (which, of necessity, would include a description of the chromosomal rearrangements) and publish it according to the accepted rules of zoological nomenclature.

The matter of artificial species of flies can be carried somewhat further. Some of the recent creations have been made from classroom strains that carry easily recognizable mutant genes. Using one of these genes (dark body color) as a convenient label, wild-type (tan-bodied) *melanogaster* and dark *artificialis* were forced to live together in the same culture for many generations. That is, every three weeks when it was necessary to transfer progeny flies from the old, exhausted culture bottle to a fresh one, both tan and dark flies of both sexes were chosen to be parents of the next generation. These flies were then placed in the fresh culture bottle.

After two years of such enforced cohabitation, tests showed that males and females of the dark and tan strains preferred to mate with flies of their own kind. Why? Because during the course of the two years nondiscriminating flies that mated with the opposite type left no surviving offspring; remember, crosses between *artificialis* and *melanogaster* are completely barren. Hence, the flies that successfully produced tan and dark progeny generation after generation were those that mated by preference with their own kind. After two years the tan and dark flies of these experiments were well on the way to becoming good biological species.

Geneticists, if they wanted and were permitted to do so, could create chromosomal rearrangements in man such that their experimental subjects would be sterile when crossed with normal human beings but fertile when crossed with one another. A zealous taxonomist could devise a name for these reproductively isolated persons if he wished. *Homo artificialis* is an obvious choice.

We know, however, that there are persons who do not, or cannot, distinguish between words and reality. These persons, armed with guns and clubs, would seek to exterminate the new species. They would ignore expert testimony that in all physical and biological aspects the individual members of *Homo artificialis* are identical to those of *Homo sapiens*. The important matter to these semantically deluded people is sex. Sex, for them, is for procreation; hence, a group of individuals that cannot produce children by human spouses, no matter what their origin, is nonhuman. "No procreation? Wait just a damned minute! Daughter, get in the house with your mother! Where's my rifle?" Am I exaggerating? I think not.

Why should my undergraduate friend have asked about the limits of humanness when speaking of genetic engineering? In order to discern when to apply for a hunting license? I suspect not, because he is much too kind, too sensitive, too intelligent for that. I cannot believe that he yearns to throttle a humanoid. Consequently, he must

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have been seeking my views on the essential characteristics of humanity. Must humanity come in human, man-like form? *Homo sapiens* is the species whose members are called human beings. Does it follow that human beings must belong to the species *Homo sapiens*?

To answer this question, we must go beyond the physical body in which each member of mankind is packaged. True, football players, movie stars, and Roller Derby queens have their temporarily attractive features; nevertheless, the individual's mind is still his most important feature. It would seem, then, that most of the physical features used by professional biologists in determining the taxonomic position of man within the animal kingdom are not essential for humanness. Indeed, many of these physical features can be lost without reducing the person to subhuman or nonhuman status. They can be literally sheared off in the tangled wreckage of an automobile without loss of identity—provided that the mind remains alive and alert.

What, then, is responsible for the humanness of man? First, his ability to perform elaborate mental simulations. For example, I can pose problems for myself with no outside prompting. One that comes to mind on the spur of the moment is the following: What would be my differing life-styles if my annual income were $1,000? $10,000? $100,000? $1,000,000? For each of these possibilities I can run through hypothetical budgets, compare essential and luxury items, and imagine the amounts that might be allotted for food, housing, and medicine. In the case of the higher incomes I can plan the concert programs I might attend, outline itineraries for future trips, and fantasize the myriad other things that a large income would make possible. Nor is my imagination in these matters restricted to a skeleton outline. On the contrary, I can zoom in and imagine even the finest architectural details of the cathedrals that I might visit on one of my imaginary travels. The entire exercise, remember, is imaginary; furthermore, the entire simulation has taken place as I have written these last four or five sentences. This ability to "live" experiences in the mind by simulation is surely an essential feature of humanness.

As a second essential feature of humanness I would list the recognition of one's self as but one of a number of equals—the acceptance of the social pact articulated in the Golden Rule (or its equivalent; different religions express it in slightly different words) as *the* outstanding restriction governing human behavior. Regardless of his other fine qualities, if my companion does not recognize the Golden Rule, he is a threat to me. I either spend excessive time and energy in guarding myself against him or, tiring of that, seek his destruction. To avoid conceding that he has destroyed my own humanity, I classify him as nonhuman. I destroy him in self-defense as I would any other dangerous pest.

Finally, in my catalogue of human qualities, there is apprehension. I hasten to admit that apprehension is not wholly independent of simulation; nevertheless, it signifies a humility or a vulnerability that is nowhere suggested by the term "simulation." The quality I have in mind was expressed by the Scottish poet Robert Burns:

Still thou art blest, compared wi' me;
The present only toucheth thee;
But och! I backward cast my e'e
On prospects drear!
An' forward, thou' I canna see,
I guess an' fear!

The humanness of man lies in part in his ability to "guess an' fear." We are, after all, the only creatures in the world capable of contemplating our own deaths. The "wee, sleekit, cowrin, tim'rous beastie" to which Burns addressed his words could not simulate, knew not the Golden Rule, and possessed no apprehension. A mouse is neither a man nor human.

"At what stage in the alteration of his product will the genetic engineer no longer regard it as human?" The opening question has become double-edged. Beginning with human eggs and sperm, the product is to be recognized as human as long as it exhibits the traits I have discussed above. If it should lack any one of these or, more importantly, if it were to lack all three, it would not be human, although lawyers might still defend the unfortunate thing as a member of mankind.

More to the point, perhaps, is the possible result of experimentation on lower forms of life. If at any stage of this experimentation it were shown that the experimental organism(s) had developed the traits I have listed as essential for humanness—simulation, acceptance of the Golden Rule, and apprehension—I would classify the product as human. Not as a member of *Homo sapiens*, because certain physical properties must be met in order to meet this taxonomic classification. Should I seek *human* company, however, I might choose the product of this genetic experimentation to many of my conspecific fellow men. This, I believe, emphasizes as well as anything the distinction between "man" and "humanity." □

"Humans": A Family Portrait

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STALKING THE MYSTERIOUS MONOPOLE

BY W. M. SCHWARZ

Although predicted some forty years ago, to date no magnetic monopoles have been detected. Nevertheless, for theoretical, economic, and even aesthetic reasons researchers are still looking.

In this age of lasers, nuclear power, and manned space flight, the common magnet seems tame and understandable. In 1820 André Marie Ampère produced a reasonably satisfactory explanation of the forces magnets exert, an explanation that has been refined in this century by application of the quantum theory. Nevertheless, a gap still exists in our understanding of magnets and magnetism, one that has led to an extensive search for an elusive, hypothetical particle known as the magnetic monopole.

The basis of this mystery is the seemingly close relationship between electricity and magnetism. Virtually every magnetic effect has an electric analogue; virtually every electric effect has a magnetic analogue. However, there is a bothersome exception. Whereas bodies carrying either positive or negative electric charges are common in nature, magnetic charges seem always to occur in pairs. It is this asymmetrical feature of the theories of electricity and magnetism that has spawned the search for a body carrying a single magnetic charge or pole—the magnetic monopole.

Anyone with an elementary knowledge of science knows that magnets have north and south poles and that if a magnet is broken in two, each section also will have a north and south pole. If the sections are further divided, each piece will still have two poles. The north pole of a magnet is arbitrarily assigned a positive sign, the south pole a negative one. Thus, it is said that the *total* pole strength, or charge, of a magnet is zero.

Similarly, the total electric charge on most familiar objects is zero: the amount of positive charge on the object equals the amount of negative charge. But with electric charges such a balance need *not* exist—an object can carry an excess of positive charge or an excess of negative charge. The negative charge is associated with the electrons of the atoms that make up the object, the positive charge with the nuclei of these atoms. Usually, since electrons are more mobile than the atomic nuclei, a negatively charged object is one that has acquired additional electrons, while a positively charged object is one that has lost electrons.

In the early 1930s the theoretical physicist P. A. M. Dirac of Cambridge University argued that—sometimes, at least—a magnetic charge should exist by itself in nature, without a partner of opposite sign. Since the common, two-poled magnet is called a "magnetic dipole," Dirac dubbed his independent magnetic charge a "magnetic monopole." Basing his argument on the quantum theory, Dirac went on to suggest that there should exist a smallest unit of magnetic charge, just as there is a smallest unit of electric charge (the charge on the electron or, its equal and opposite, the charge on the proton). Dirac also predicted that magnetic monopoles should exist only in multiples of this smallest unit of magnetic charge, just as electric charges found in nature are always whole-number multiples of the charge on the electron or proton.

Dirac's theory that magnetic monopoles *ought* to exist is widely respected by physicists; yet no monopoles have been observed to date. To be sure, searches have been made, but they have all been unsuccessful. Then why continue? Why bother to find another esoteric particle in nature when there already is a formidable list of elementary particles, among them positive and negative electrons, positive and negative protons, the neutron, the neutrino, and a variety of short-lived entities that exist briefly and then disappear? To find a new one would be interesting, of course; however, there are more fundamental concerns at stake.

In science it is an article of faith that nature is not capricious. All scientific effort is based on the assumption that events and phenomena of the world we study do not "just happen" but are interrelated in some logical pattern that we should be able to discover. However, there is one important, fundamental observation that has not yielded to "explanation"—has not yet been related to any other property of nature. This is the apparent fact that all electrons are alike. Wherever they are observed—whether in the laboratory or indirectly by the light from remote stars—electrons all have the same mass and the same electric charge. The charge they carry is always the smallest unit of charge that exists. Furthermore, the electric charge on any object is always a whole-number multiple of

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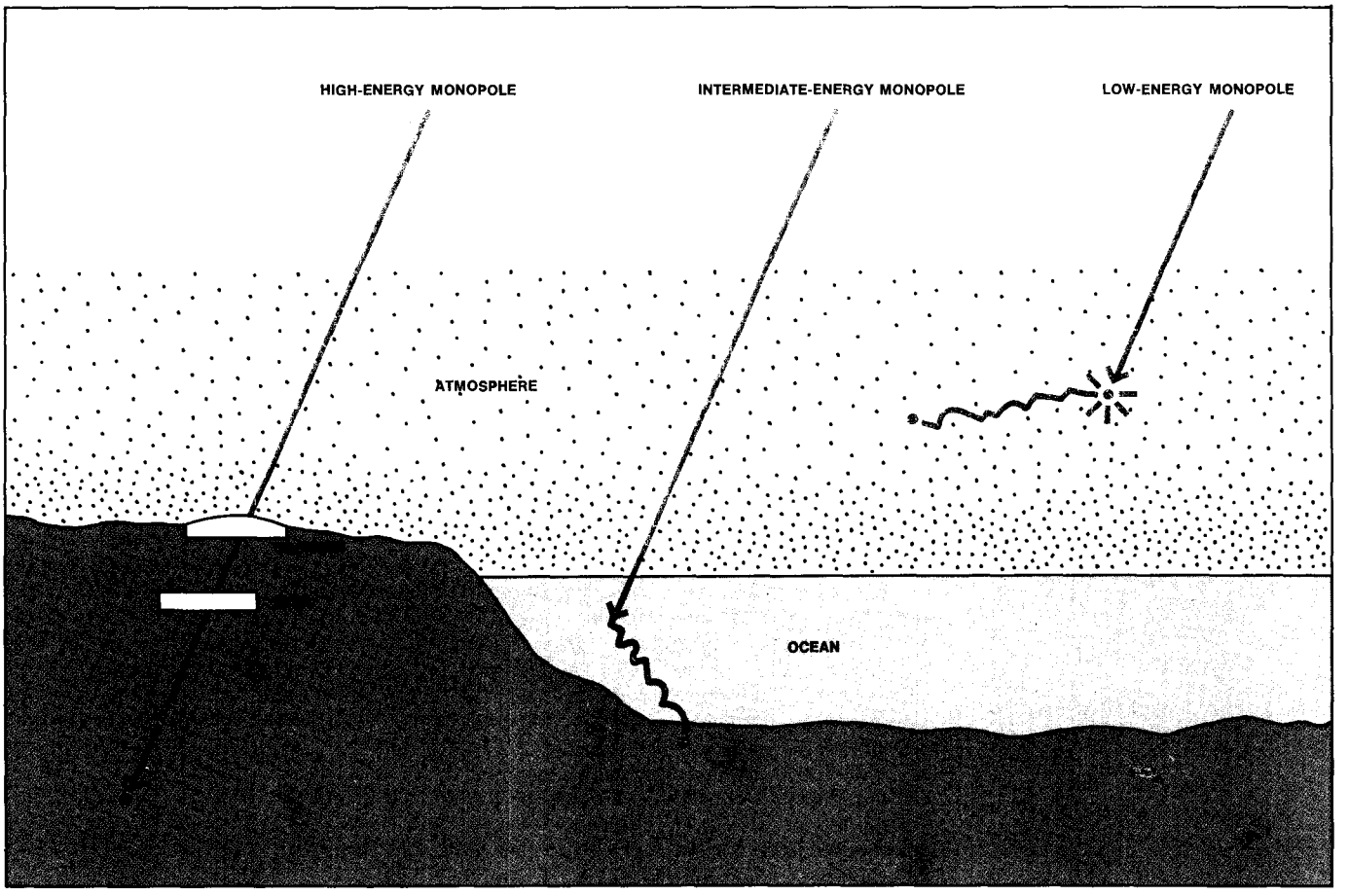

this elementary charge on the electron. Although these conclusions are based on several generations of scientific observation, there seems to be no logical necessity—no "explanation"—for this uniformity.

Dirac's theory, however, suggests a logical connection between the electrical properties of the electron and the magnetic properties of the monopole. According to Dirac, if a monopole exists anywhere in the universe, then there must exist an unambiguous relation between the magnetic charge on this monopole and the electric charge on an electron. The product of the electron's charge and the charge on the monopole must be some combination of two of the fundamental constants of nature—the velocity of light in a vacuum and the smallest unit of angular momentum, both accurately known quantities. Discovery of a single monopole would support this theoretical relationship and perhaps answer one of the most puzzling questions in physics.

Another puzzle that might be unraveled by the discovery of a single magnetic monopole lies in the space between the stars. This space is not completely empty but contains a variety of particles, including electrons, atoms, molecules, and dust particles (aggregates of many molecules). A few of these particles strike the earth as it travels through space. When first observed, they were labeled "cosmic rays," and the name, with its rather poetic ring, has been retained.

Arriving from outer space, cosmic rays bombard the earth in a great range of energies, most of which can be justified in terms of what we know about our galaxy and intergalactic space. But those that arrive with the highest energies, although few in number, just don't fit in with our picture of the universe. The way in which the universe appears to be expanding is not consistent with the amount of energy these cosmic rays require. However, if these high-energy cosmic rays turn out to consist of monopoles, then their energy would be consistent with our current picture of the universe, and the puzzle would be solved.

There also is a more pragmatic motivation for the monopole search. Essentially, all discoveries in nuclear and subnuclear physics have been made with the aid of high-speed (high-energy) particles that are used as projectiles to produce changes in atoms. Knowledge of the nature of these changes leads to knowledge of the inner nature of atoms. To date, however, only projectiles with electric charge have been available to be accelerated to the speeds required, and the acceleration of electric charges requires very large and very expensive devices. But if monopoles were available in the laboratory, they could be accelerated to high speeds by means of magnetic fields. The production of magnetic fields for accelerating magnetic particles would require devices costing several tens of thousands of dollars: to accelerate electric particles requires devices that cost millions. Furthermore, if magnetic monopoles were available, they could be trapped in iron, pulled out and accelerated in magnetic fields, and then retrapped in more iron after they have bombarded the atoms under study. Thus, they could be used over and over again.

Finally, there is what might be called an aesthetic interest in the discovery of a monopole. About a century ago the English scientist James Clark

The predicted characteristics of monopoles suggest several hunting grounds, among them the depths of the earth, the ocean bottom, and the atmosphere. High-energy monopoles should penetrate the surface of the earth, leaving path marks in such materials as mica and obsidian. Intermediate-energy monopoles should come to rest on the ocean's bottom. Low-energy monopoles should be stopped by the atmosphere, where they would then float toward one of the earth's magnetic poles unless trapped by an outcropping of iron.

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$$\nabla \cdot \mathbf{E} = \rho_e/\epsilon$$

$$\nabla \cdot \mathbf{H} = \rho_m$$

$$\nabla \times \mathbf{E} = -\mu(\mathbf{J}_m + \partial\mathbf{H}/\partial t)$$

$$\nabla \times \mathbf{H} = \epsilon(\mathbf{J}_e/\epsilon + \partial\mathbf{E}/\partial t)$$

The equations above, describing the interactions of electric charges, electric fields, and magnetic fields, were formulated in the late nineteenth century by the English scientist James Clark Maxwell. **E** represents the electric field; **H**, the magnetic field; ρ_e, the charge density; $\mathbf{J}_e$, the current density; ρ_m, the magnetic charge density; $\mathbf{J}_m$, the magnetic current density. ϵ and μ are constants. However, since magnetic charges or monopoles are not known to exist, ρ_m and $\mathbf{J}_m$ must be replaced by zeroes; if a monopole were discovered, the equations would become essentially symmetrical and thus more aesthetically pleasing to the physicist.

Maxwell developed a remarkable set of equations that describes the interactions of electric charges, electric fields, and magnetic fields. To the mathematician and physicist these are aesthetically beautiful relationships. They are relatively simple and have survived a century of testing and application without modification.

As Maxwell's equations are usually written, they are four in number, grouped in pairs. In each pair the member equations are of the same form except that the symbols for electric field and magnetic field are interchanged and the symbol for electric charge in one becomes a zero in the other. The zero is there because independent magnetic charges—magnetic monopoles—are not known to exist. However, were there free magnetic charges as there are free electric charges, the equations would become symmetrical; in any one equation we essentially could replace the symbols for the electric field and charge with the symbols for magnetic field and charge and obtain (except for characteristic constants) one of the other equations. The physicist would find great aesthetic satisfaction in such a beautifully symmetric set of equations that so fully describes the whole range of electric and magnetic phenomena. But without the monopole these equations remain incomplete.

It thus appears that, whether for theoretical, economic, or aesthetic reasons, the search for the elusive monopole should continue. But where might one begin to look?

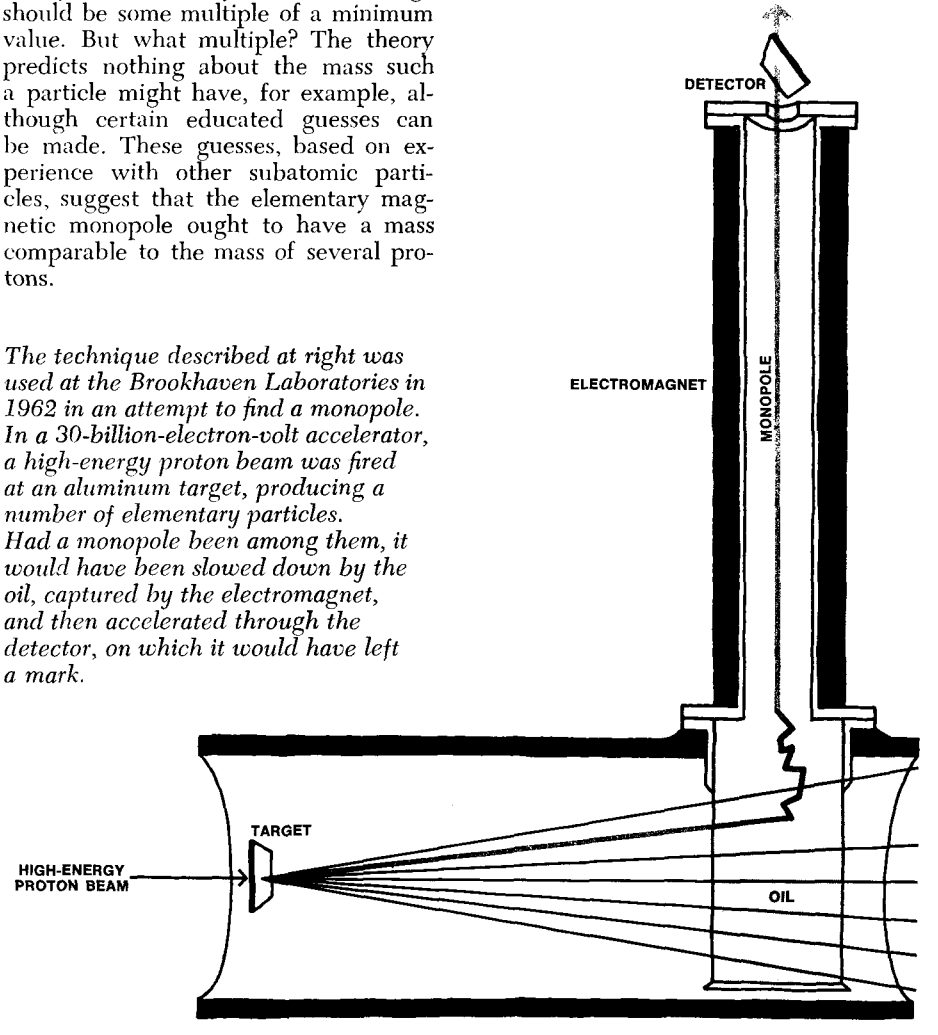
The search immediately can be narrowed by excluding macroscopic objects. Within our experience all macroscopic objects that display magnetic effects—bar magnets, compasses, the earth itself—are dipoles: they have equal and opposite poles and hence zero net magnetic charge. The search must be conducted in the atomic and subatomic realms.

Helpful in the search would be some detailed notion of the properties of the monopole. However, Professor Dirac's theory tells us only that the charge should be some multiple of a minimum value. But what multiple? The theory predicts nothing about the mass such a particle might have, for example, although certain educated guesses can be made. These guesses, based on experience with other subatomic particles, suggest that the elementary magnetic monopole ought to have a mass comparable to the mass of several protons.

It is conceivable that such particles exist out in the space of our galaxy. They may have been formed during the superexplosion that many now believe to have been the origin of our universe. It is known that there is a weak magnetic field in our galaxy, and if such particles have been floating around, this magnetic field should have continually accelerated them to higher and higher speeds. In the billions of years since the original explosion, these monopoles should have been accelerated to incredibly high energies, and from time to time at least a few of them should crash into the earth.

Assuming that monopoles exist and that at least a few of them occasionally impact our planet, several possible hunting grounds suggest themselves. If monopoles reach the earth with high energy—the highest yet observed in cosmic rays, for example—they would plow through the atmosphere, penetrate ocean or continent, and end up deep in the earth. If monopoles impact the planet with intermediate energy, it is likely that some will come to rest on the ocean bottom. Still lower-energy

The technique described at right was used at the Brookhaven Laboratories in 1962 in an attempt to find a monopole. In a 30-billion-electron-volt accelerator, a high-energy proton beam was fired at an aluminum target, producing a number of elementary particles. Had a monopole been among them, it would have been slowed down by the oil, captured by the electromagnet, and then accelerated through the detector, on which it would have left a mark.



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monopoles should be stopped by the earth's atmosphere, after which they should float in the earth's magnetic field toward either the North or South Pole. However, before they reach the poles of the earth, it is likely that some will be captured by outcroppings of iron ore.

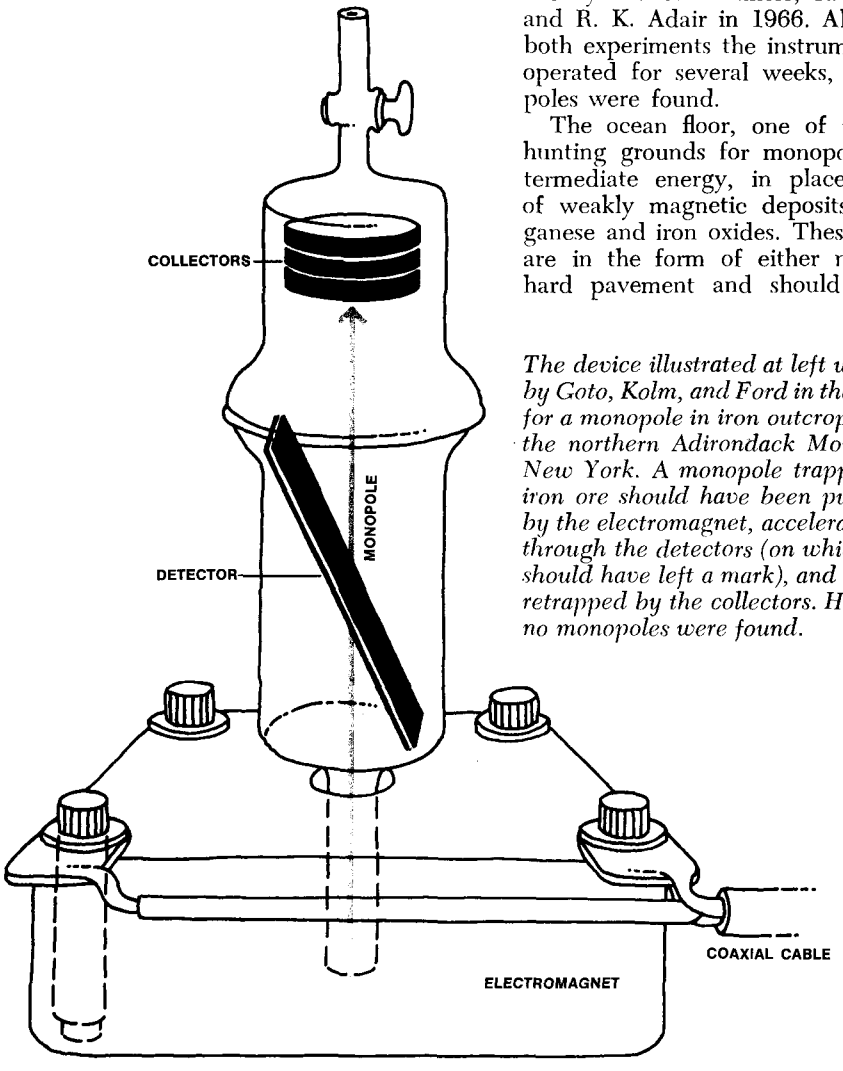
In 1963, working on this last possibility, Eiichi Goto, Henry Kolm, and Kenneth Ford of the Massachusetts Institute of Technology's National Magnet Laboratory searched for monopoles trapped in exposed iron-ore outcroppings in the Adirondack Mountains of New York. If a monopole had been captured by one of these outcroppings, it should still be lodged near the surface. A reasonably strong magnetic field could be applied to attract the monopole, pull it loose from the outcropping, and send it through a photographic emulsion, on which it would leave a mark.

Goto, Kolm, and Ford backpacked instruments, including a small generator, to Brand Pinnacle in the northern Adirondacks, where there is a suitable outcropping. However, they could find no evidence of magnetic monopoles. Either erosion had removed the surface layer of the ore and thus the monopoles, or monopoles do not possess sufficiently low energy to be trapped in such outcroppings. Or perhaps there simply are no monopoles.

Goto, Kolm, and Ford also used this technique on samples of iron meteorites that might have picked up magnetic monopoles during the billions of years they floated in space. Again, no monopoles were found. Possibly the outer surfaces of the meteorites burned away during entry into the atmosphere. Perhaps the meteorites were too small to stop and trap the monopoles. Again, perhaps there are no monopoles. (Recently, Luis W. Alvarez of the University of California's Lawrence Radiation Laboratory examined moon rocks returned by Apollo astronauts for trapped monopoles. His results also were negative.)

It also has been suggested that low-energy monopoles may have attached themselves to oxygen molecules (which are slightly magnetic) in the atmosphere. In 1951 W. V. R. Malkus employed a collecting magnetic field to trap monopoles linked to oxygen molecules. A similar experiment was carried out by W. C. Carithers, R. Stefanski, and R. K. Adair in 1966. Although in both experiments the instruments were operated for several weeks, no monopoles were found.

The ocean floor, one of the prime hunting grounds for monopoles of intermediate energy, in places consists of weakly magnetic deposits of manganese and iron oxides. These deposits are in the form of either nodules or hard pavement and should have attracted and trapped monopoles settling on the ocean floor. Moreover, certain of these deposits have developed on a glassy lava constituent, the age of which can be determined. Age measurements indicate that these deposits have been developing for some 16 million years.



The device illustrated at left was used by Goto, Kolm, and Ford in their search for a monopole in iron outcroppings in the northern Adirondack Mountains of New York. A monopole trapped in the iron ore should have been pulled loose by the electromagnet, accelerated through the detectors (on which it should have left a mark), and then retrapped by the collectors. However, no monopoles were found.

In 1968 Robert E. Fleischer, P. Buford Price, Howard H. Hart, Isador S. Jacobs, Richard T. Woods, and I, working at the General Electric Research and Development Center in Schenectady, New York, examined samples of these ocean-floor deposits. Altogether some eight kilograms of ocean bottom were tested, but no monopoles were discovered. Since there is a limit to the sensitivity of any scientific instrument, our negative results did not completely eliminate the possibility that intermediate-energy monopoles have impacted the earth. However, from a knowledge of the limitations of our equipment, we were able to state that it is 90 per cent certain that no more than one monopole of the intermediate-energy range could have reached any square foot of the earth's surface in the last ten million years.

One of the prime hunting grounds for high-energy monopoles, the depths of the earth, is not readily accessible to the searcher. However, if monopoles have penetrated the earth's crust, they should have left signs in their wake, especially in such surface materials as mica and obsidian that have high electrical resistivity. It is known that high-speed particles produce localized damage to the atomic structures of such materials as they pass through them. This damage can be made visible by immersing the sample in an etching solution that dissolves the damaged regions more rapidly than the bulk material, producing tunnels that can be seen readily with a low-powered microscope. Samples of mica and obsidian of known age have been examined, but no tracks of the kind a monopole should make have been discovered.

Another search for high-energy monopoles has taken place in the particle accelerators of such institutions as the Brookhaven Labs in New York and the CERN organization in Switzerland. Although a host of esoteric particles have been produced in these accelerators, no monopoles have been among them. However, these accelerators could produce only monopoles with masses less than about three times the mass of the proton. The negative results of the accelerator experiments make it likely that if monopoles exist, their mass is appreciably greater than the mass of three protons.

To date, then, the search for a magnetic monopole has been unsuccessful. It now awaits some new ideas. □

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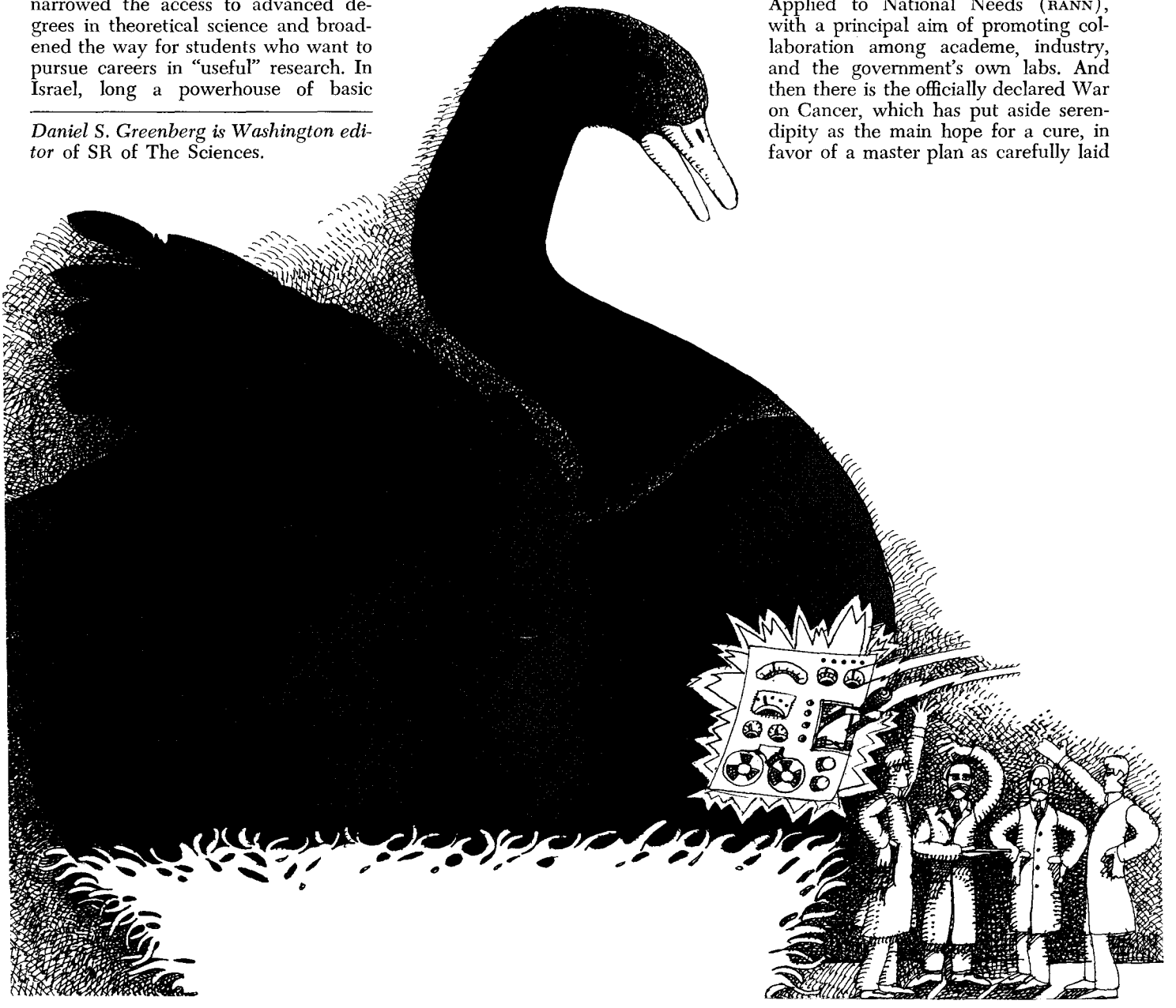
MANAGING THE SCIENCE GOOSE

BY DANIEL S. GREENBERG

Excited by the valuables that have emanated from research over the past few decades, governments around the world have lately taken to the notion that there must be some way to program the technological goose for speedier output of such golden eggs as fast-selling electronic products, beneficial drugs, new sources of power, and so forth.

Thus, the Soviet Union last year narrowed the access to advanced degrees in theoretical science and broadened the way for students who want to pursue careers in "useful" research. In Israel, long a powerhouse of basic research, scientists are now strongly encouraged to moonlight on marketable products, and the government provides heavy subsidies for research in private industry. In Britain, following a lengthy study under Lord Rothschild, an industrial researcher, the government recently revamped the process for distributing its research funds so that social and industrial needs will receive a higher priority. In the United States the National Science Foundation, traditionally the bank for basic research in universities, now puts some 10 per cent of its budget into projects that come under the heading of Research Applied to National Needs (RANN), with a principal aim of promoting collaboration among academe, industry, and the government's own labs. And then there is the officially declared War on Cancer, which has put aside serendipity as the main hope for a cure, in favor of a master plan as carefully laid

Daniel S. Greenberg is Washington editor of SR of The Sciences.



MIKE BULL

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out as the schedule for bringing a new jetliner into existence.

Only a Luddite churl would quibble with the basic intent of these efforts, which is to maximize the benefactions of science. Curiously, there is a silent harmony of interest in these matters between political opposites, notably between President Nixon, who pressured the National Science Foundation into taking on its applied-research program, and the radical Science for the People movement, composed mainly of young scientists, many of them dropouts, who are disillusioned with the perversion of the humanitarian potential of science. The two sides part on the momentous issues of science for war, corporate exploitation of the fruits of science, and the hierarchical, elitist structure of the scientific community. But both seek to revamp the national scientific enterprise in behalf of research to satisfy what they perceive as important human needs.

A question that arises from this worldwide trend toward utilitarian research is, quite simply, Can it work, or is there something in the genes of the research endeavor or in the surrounding social milieu that defies acceleration of the innovative process? It's an important question, one that is increasingly troubling to many traditionalist members of the scientific community, for if too much is expected of research and it fails to deliver, the ensuing public and governmental disappointment could touch off a tailspin in financial support for the established institutions of research and bring to the fore alternatives that the regulars are prone to term "quack." The model that provides grounds for concern is the biomedical field, which has proven especially vulnerable to fadism. Thus, there is a proliferation of back-alley cancer "cures" in the face of conventional medicine's repeated failures, while a variety of guerrilla psychotherapeutic schools thrives in response to the uncertain record of Freudian-based psychiatric techniques.

Some aspects of the workability question are relatively clear and more or less agreed upon; others are among the obscurities of the history of science and technology, itself a proliferating field of scholarship as governments strive for a better understanding of the innovative process.

Where basic principles are well understood, as they amply are in the physical sciences and engineering, there is no doubt that a generous mix of money, manpower, and management can fill a variety of prescriptions, whether for cleaner automobile engines, faster computers, or substitutes for natural materials. The atom bomb and the moon landings are examples of scientists' and engineers' building from basic knowledge that was previously confined to the printed page. The process can be likened to constructing a bridge across a wide strait: it is difficult, but with what is known about bridge building, the presence of the three-part mix guarantees success.

Difficulties arise, however, when there is a mismatch between the laboratory's ability to perform and society's interest in using the knowledge, which accounts for the fact that only a small percentage of patented ideas ever gets to the production stage and that even when they do, the market often proves unreceptive. A prime example is DuPont's disastrous experience with a man-made leather substitute, Corfam, which, after enormous investments in research, production, and marketing, satisfied all criteria—but customer acceptance. Perhaps even more important are the so-called institutional barriers that impede the application of new ideas. The construction industry, bounded by restrictive building codes and make-work union regulations, is an example of a major part of the economy that has been shielded from new technology.

The greatest uncertainties in science-to-order is in basic research, of which Eisenhower's Defense Secretary, Charles E. Wilson, annoyed by the high costs and unpredictable results, once said, "Basic research is when you don't know what you're doing." But, as it turns out, basic research—the quest for fundamental knowledge of how the world functions—is often the missing link in getting things done. Sometimes it can be carried out on the basis of precise planning aimed at elucidating the laws of nature so they can be exploited for specifically intended purposes, as was the case with Bell Labs' development of the transistor as a successor to the vacuum tube. But the history of science is strewn with innumerable examples of curiosity, linked to no purpose but, perhaps, personal glory, turning up understandings that eventually proved to be immensely utilitarian. Roentgen, whose discovery of X rays was honored with the first Nobel Prize in physics, did not have dentistry or orthopedics in mind when he noted that a cathode-ray tube affected a paper coated with photosensitive material. But he very quickly employed his discovery for looking at the human skeleton, and the medical profession took over from there. When Watson, Crick, Wilkins, and company went after the double helix, their chief inspirations were a desire to know and an urge to collect their first Nobel Prize rather than see Linus Pauling get his second. But the double helix is as likely as any discovery to provide a key to the cancer riddle.

The question of how much management basic science can stand is a hot one, with purists arguing that fundamental knowledge cannot be dished up to order any more than a novel like *War and Peace* can be produced by government fiat, no matter what the quantity of money, men, and management. But whatever its merits, that point of view is receding virtually all over the world. If poets wish to scribble, that's their business, the political managers say. But when large amounts of public money are involved, as they are in the conduct of basic research, the public has a right to ask the scientist to harmonize his curiosity with the quest for knowledge that will provide needed pieces for completing the puzzle. The purists contend that the politicians proceed from ignorance; the politicians write the scientists off as unduly precious at public expense. But since politicians rather than scientists man the treasury, the trend is definitely toward "targeted" research.

Since science and technology do indeed have a great potential for improving man's lot, the present worldwide trend toward government interest in putting them to work is commendable and overdue. The dangers, however, are that excessive expectations can lead to confusion between purely technical problems and political problems that contain technical components. Science and technology are the easy part of the environmental problem; the tough part is political leadership and public willingness to meet the costs in both money and altered life-styles. And then, too, there is a menace in the processes that necessarily accompany the governmental presence. Many layers of chiefs over the man at the lab bench is not often the best formula for creativity. Committees are not good for spontaneity, but inventive loners are hard to explain to the accountants.

Governments worldwide have told their people that they are going to bring scientific benefactions from the vasty deep. Like Hotspur, we are in the position of wondering, "Will they come when you do call for them?" □

Postscript. Recently in this space I suggested that someone ought to give a medal to Richard Garwin, one of IBM's top scientists, for his exemplary and probably unique public service in breaking ranks with the public-silence custom of the federal-advisory system and openly campaigning against the SST, which he had studied for the White House. Well, the thought was long ago anticipated by the Federation of American Scientists, which, in December 1971, bestowed upon Garwin its first annual Public Service Award "for courageous and effective testimony on the SST."

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A movable (disappearing) feast

BY KENNETH E. F. WATT

In the last five years an important, fundamental, and widely applicable new scientific principle has come into the literature from three remarkably different sources. The principle can be expressed as follows:

The diversity, or variety, in any natural system is inversely proportional to the rate of energy flow through the system.

Harold J. Morowitz, a biophysicist at Yale, discovered that this principle was applicable to molecular systems. Ramon Margalef, a marine biologist in Spain, pointed out that in ecological systems, when productivity (energy flow) is high, diversity is low (agricultural crops, algal cultures); when productivity is low, diversity is high (tropical rain forests). Jane Jacobs, the architectural writer, has noted that in cities in which economic activity is concentrated in a few industries (low diversity), the manufacturing process (high rate of energy flow) is highly efficient, on average. In cities in which economic activity is scattered through a great many industries (high diversity), the average citywide efficiency is lower. Economies of scale are more likely where there is less diversity. Seattle (Boeing) and Detroit (car manufacturing) are examples of low-diversity, high-energy-flow cities. Cambridge, Massachusetts, and Palo Alto, California, are high-diversity, low-energy-flow cities.

In short, this principle suggests that variety is inimical to very high rates of energy flow through a system, or that high rates of energy flow through systems are inimical to variety.

This principle may be of much greater significance than is generally recognized, for two reasons. First, there is an obvious trend running in the industrial world toward greater rates of flow of energy through all systems. For example, the average person in the world used 9.5 per cent more energy in 1969 than in 1967. Second, there is considerable evidence that variety has a significant effect on the human nervous system. We know that if a person is left in a cell with absolutely no sensory input, he will begin hallucinating within a few days. We also know that the body can literally twitch if the rate of incoming sensory input is too high. These two extreme reactions suggest that there is some intermediate level of sensory stimulation, or environmental diversity, that is optimal.

A host of anecdotal observations suggest that optimal diversity for the human nervous system is higher than the average environmental diversity in which most of us typically live. The pleasure many people experience from the night life of London or Paris, a very large zoo, an art gallery, or a restaurant with a 150-item menu suggests that most of us have an appetite for environments with optimal diversity. (Along this line, it is worth noting the recent dramatic increase in the popularity of viewing coral reefs by snorkeling or scuba diving.)

Having read this far, many people will reflect that the diversity of life in North America may be lower than

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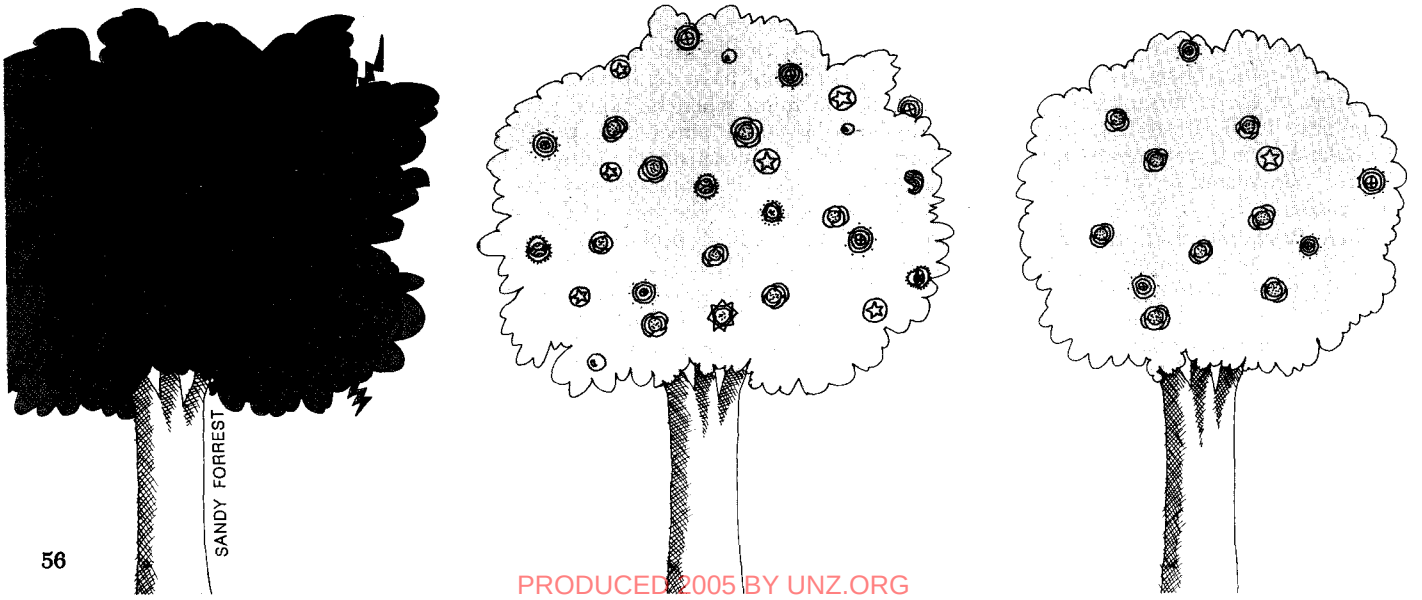

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elsewhere and that this may be related to the high rate of energy flow through society here. Many casual observations support this notion, but interesting statistics are available that tend to confirm them.

COUNTRY	PER CAPITA CONSUMPTION OF ALL FORMS OF ENERGY IN POUNDS OF COAL EQUIVALENTS	BOOK TITLES PUBLISHED PER YEAR PER MILLION PEOPLE*
United States	23,752	306
Canada	19,387	174
Finland	7,884	1,249
Switzerland	6,993	1,206
Denmark	11,336	1,018
Sweden	12,716	928
Netherlands	10,276	868
Israel	4,749	722
United Kingdom	11,329	582
Czechoslovakia	13,492	562
West Germany	10,692	560
New Zealand	5,783	459
France	7,756	371
Australia	11,464	320

**These statistics were collated or calculated from statistics published in the* Statistical Yearbook of the United Nations.

For example, it is clear from the *Statistical Yearbook of the United Nations* that while the United States and Canada have between two and five times the energy consumption per capita of any other developed country, the number of book titles published per year per million people is higher in at least twelve other industrial countries. Indeed, six other nations publish between two and a half and four times the number of book titles per capita as the United States. Could there be a causal relation between high numbers of book titles published per capita per year and a lower energy consumption per capita per year?

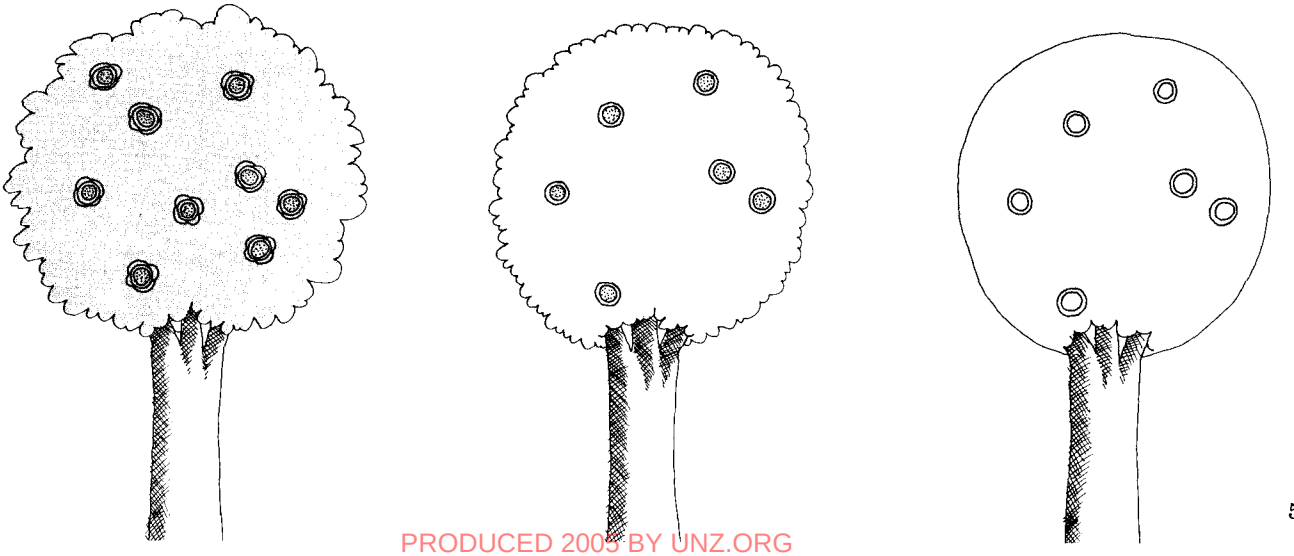
Clearly, the life-style that emerges from nations that emphasize efficiency through economies of scale and that consume large amounts of matter and energy will not support publication of a large number of book titles every year. While driving the camper to a campsite or flying to Honolulu, one is not likely to be reading Teilhard de Chardin or Jacques Ellul, even though these typically European writers have some very important messages for people engaged in those activities.

Suppose we grant that diversity and energy flow are inversely proportional, that humans need diversity, and that energy flow in the world is increasing. Is there any evidence that the increased energy flow is actually leading to a decrease in diversity?

We can all think of innumerable examples in which the trend toward efficiency and the economies of scale made possible by a vast operation has diminished variety. *Life* and *Look* are no longer with us, a very large number of automobile manufacturers in the United States has been reduced to four, an amazingly high proportion of all the commercial airline operations in the world use the planes made by just two companies, and even RCA had to vacate the large-computer manufacturing field. Our food is becoming remarkably standardized, and restaurants in most cities are becoming notably similar to each other in décor as well as product. To an astonishing extent our symphony orchestras play the music of eight men, and popular music is more remarkable for its homogeneity than its diversity. In my opinion one of the most powerful symphonies ever written in the United States is the Sixth by none other than Peter Mennin, the president of Juilliard; yet it has only been recorded once. The economics of our present popular culture are intolerant of experimentation.

It appears to be an unrelated fact that the number of species of plants and animals in the world is declining and will decline very much more if the human population increases much and the energy flow per person increases much. This reduction of species can result only in a further impoverishment of the human environment—fewer treasures to feast our senses on.

Is it a matter of luxury or necessity for us to be concerned about the rising world level of energy flow and the drop in the diversity of the environment that will almost surely follow? The very deep, instinctive feelings aroused in the reader by this question probably provide the truest answer. □



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LIFE SCIENCES

Eden and Evolution

Thousands of California children are taught at home that the Bible's version of the origin of man is the only true account. These same children are then confronted at public school with Charles Darwin's evolutionary explanation of how man came to be. For parents in home after home the conflicting explanations have caused a crisis of belief. Last month fundamentalist churchgoers, who believe that the Bible is the literal word of God, capped nearly a decade of hard lobbying with a major victory. The State Board of Education agreed to alter the wording of new science textbooks so that evolution will be taught as speculative theory, not "scientific dogma."

From now on children in the fourth and sixth grades will learn that Darwin's theory of evolution is simply science's way of guessing how man was created. Modified textbooks will expose what the board has decided are holes in the theory—areas in which scientists have no hard proof for evolution.

The decision is expected to have nationwide repercussions. California buys 10 per cent of all the textbooks published in the United States, and most publishers design their textbooks for this lucrative market. Once the demanded changes are made to satisfy the Board of Education in the nation's most populous state, it is unlikely that publishers will spend the additional sums necessary to publish an unexpurgated version for the other forty-nine states.

Scientists feared the board would go even farther and give in to the fundamentalists' demand that competing religious theories about man's origin be put side by side with Darwin's. The evolutionists won a compromise only by bringing big guns to bear, including the National Academy of Sciences, the American Chemical Society, various associations representing science teachers, nineteen Nobel prize-winning scientists in California, and several faculty senates at the campuses of the University of California.

An editorial in the journal of the American Association for the Advancement of Science spelled out clearly the arguments of all of these groups. It was read at a marathon hearing the board held in November that almost rivaled the Eden-versus-Evolution debates of the 1925 Scopes trial. "During the past century and a half," the editorial stated, "the earth's crust and the fossils preserved in it have been intensively studied by geologists and paleontologists. Biologists have intensively studied the origin, structure, physiology, and genetics of living organisms. The conclusion of these studies is that the living species of animals and plants have evolved from different species that lived in the past. The scientists involved in these studies have built up the body of knowledge known as the biological theory of the origin and evolution of life. There is no currently acceptable alternative scientific theory to explain the phenomena.

"And God created man in his own image, in the image of God He created him; male and female He created them."—*Genesis 1:27*

"The various accounts of creation that are part of the religious heritage of many people are not scientific statements or theories. They are statements that one may choose to believe, but if he does, this is a matter of faith, because such studies are not subject to study or verification by the procedures of science. A scientific statement must be capable of test by observation and experiment. It is acceptable only if, after repeated testing, it is found to account satisfactorily for the phenomena to which it is applied."

The fundamentalists argued that there are large unexplained gaps in the fossil record. Therefore, they said, believing in evolution was just as much a matter of faith. They also charged that despite such gaps, overzealous scientists had created a sort of nontheistic religion out of evolution.

Under the terms of the ruling, changes will go into the textbooks in September 1974. In one book the statement "It is known that life began in the seas" will be altered to read: "Most scientists believe that life may have begun in the seas." Another sentence in the book states that the oldest rocks contain no fossils and adds: "These rocks are from periods before life began or from periods when the only forms of life were minute and soft-bodied and left no fossil remains." This would be changed to read: "These rocks are from periods before life began or from periods when the only forms of life left no fossil remains. Thus scientists can only speculate about the character of these early life forms."

Another book now states: "All scientists do not agree on when and how the earth was formed." This "dogma" would be changed to read: "Scientists are not sure when and how the earth was formed"—a statement sure to instill confidence in every child who reads it.

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How could the Board of Education in the largest state in the union unanimously decide that the entire scientific community was wrong and a handful of laymen were right? It took nearly ten years of pressure, carried on with evangelical zeal and coupled with abrupt political changes, to evolve that situation.

In May of 1963 Mrs. Jean Sumrall and several like-minded women first appeared before the board to protest the teaching of Darwin as fact. The board at that time was markedly liberal, having been appointed by Democratic Governor Edmund G. "Pat" Brown. But in December of that year even that board made a small concession to the churchgoers, unanimously approving the following policy statement:

"Future state textbooks dealing with the subject of man's origins should refer to Darwinian evolution as an important scientific theory or hypothesis. California teachers should be encouraged to teach Darwinian evolution as theory rather than as a permanent, unchanging truth . . . ."

This appeased the petitioners somewhat, but they had only begun to fight. Their next target—equal billing of Eden and evolution in the books. In 1966 Governor Ronald Reagan was elected, and the political pendulum moved sharply to the Right. The creationists approached the board again, only to find that new science textbooks were not up for adoption that year. Three years later, however, when the board was considering textbook specifications, they returned.

The battle widened. Although the new Board of Education was more conservative, the State Curriculum Commission was not, and it protested publicly the board's announced intention to make Darwin compete with Genesis. The commission pleaded with the board to approve the framework it had written, but the all-Christian board refused. When the textbook framework was finally approved the following year, it contained two new paragraphs calling for competing religious theories.

"I cannot look at the universe as the result of blind chance, yet I can see no evidence of beneficent design, or indeed of design of any kind, in the details."—*Charles Darwin*

Of all the publishers competing for part of the multimillion-dollar contract, however, only two submitted books that attempted to meet the criteria; neither of these was recommended, because the commission felt the overall quality was too low. One went so far as to pull its biographical sketch of paleontologist L. S. B. Leakey and replace it with Michelangelo's version of the Creation. A ten-page chapter on genetics was also chucked in favor of a lengthy discussion of the various theories of the origin of man. Last month the board—which has final say on what curriculum materials are used in the first eight grades—nearly adopted these two books or others like them.

The battle in California is not over. One of the ten seats on the board is vacant. If Governor Reagan appoints another member sympathetic to the fundamentalists, the creationists will have the six votes they need and pupils in the Golden State might yet be learning about creationist theories in science classes.

At the meeting last month the creationists made it clear their campaign would end only with total victory. Asked if she was happy at their accomplishments so far, Mrs. Sumrall agreed that she was. "Now I'm going to ask for more," she said.

RON MOSKOWITZ

Virgin Births

Virgin birth in man, as recounted in the Bible, has been disputed by countless scholars. Parthenogenesis, however, —the development of eggs without benefit of fertilization—is a way of life for a number of other animals, occurring with varying frequency in such beasts as rotifers, plant lice, and honeybees. The actual mechanism has been poorly understood—in one famous experiment adult frogs were mysteriously produced by simply pricking frog eggs with a needle.

Scientists at Penn State and the U.S. Department of Agriculture in Beltsville, Maryland, are currently attempting to clarify the nature of virgin birth among even higher animals—turkeys. Their results so far hint strongly that the phenomenon may be induced by viruses. This correlation, if confirmed, could be of great significance, since viruses are also attracting unprecedented attention among cancer researchers. Cancer and parthenogenesis are similar in that they both feature the sudden proliferation of cells, and there is a growing suspicion that viruses—little more than packets of genetic material—may account for such abnormal genetic behavior.

While such a possibility quickens the pulse of basic researchers, the project was inspired for a far more prosaic reason: the half-billion-dollar-a-year turkey industry is losing millions of dollars each year due to infertile eggs. Something triggers asexual development of a small percentage of turkey eggs, but fewer than one per cent of these hatch as parthenogenetic offspring. Better understanding of this triggering mechanism could lead to prevention of such losses.

Drs. Edward Buss of Penn State and M. W. Olsen of the USDA suspected that the cause was an outside agent. To test this idea, they isolated two sets of turkeys specially bred for their tendency to give virgin birth and inoculated one group with a fowl virus. The control group produced just eggs; the inoculated birds yielded some embryos.

Now Buss and Olsen have begun mating birds in the presumed absence of virus, then remating them after vaccination. "What we are after," says Buss, "is evidence as to whether the outside agent causing parthenogenicity is passed on 'piggyback' from one generation to another. This would mean it had not only stimulated virgin birth but had infiltrated the cell nucleus and caused a genetic change."

If the process proves controllable, virgin birth might quickly change from a liability to an economic advantage. By deliberately inducing parthenogenesis in selected turkeys, a line of "superbirds" might be produced that are genetically "clean," carrying only the desirable genes of the pedigree parent. □

Backward Growth

Two scientists at the University of Wisconsin, using the larvae of dermestid beetles, have shown that insects deprived of food tend to "grow backward." Instead of progressing toward the normal pupa stage, lab-raised beetles regressed via molting to earlier stages of development. When, after several months of starvation, they were fed once again, they returned to the normal path toward maturity, molting "forward" and regaining the weight and size they had lost. If again isolated before pupating, they would regress once again and then, when fed, go forward. Stanley Beck and R. K. Bharadwaj by this simple means raised larvae more than two years old, compared with the insect's normal life-span of eight weeks from the egg to the death of the spent adult.

These larvae were far from achieving immortality, however; each successive regrowth required more time than did the previous one, extending from nine days in the first to twenty-eight days in the fourth cycle. The two biologists hope to discover why regenerative capacity declines and perhaps assemble clues to the basic causes of aging. □

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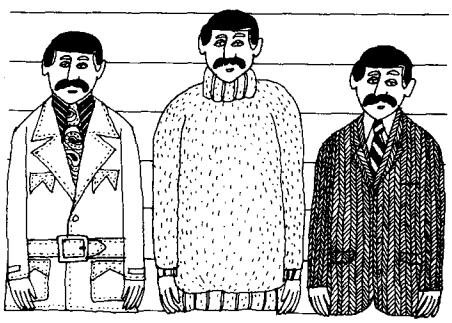
SOCIAL SCIENCES

Blind Justice?

"I could never forget that face," said the witness on the stand, and the jury, convinced, found the defendant guilty as charged. But was the witness correct? Perhaps not. Over the past eighty years psychologists have discovered that what a person hears, sees, and remembers depends on an extremely wide variety of factors, ranging from the



weather to the witness's frame of mind at the time. In spite of this knowledge, why does eyewitness testimony still enjoy such a prominent position in our legal system?

According to psychologist Robert Buckhout, part of the problem is that people are unaware of the research findings in this area. To help rectify this situation, Dr. Buckhout and his colleague, Dr. Eugene Johnson, recently organized the Center for Responsive Psychology at the Brooklyn College campus in New York. Hoping to act as a catalyst between the social sciences and law, the center will train students interested in legal careers or in related fields of psychology.

Although the center has been in existence for only a few months, it is already engaged in research on eyewitness reliability. The center's aim is the discovery of the conditions or procedures tending to bias a witness's testimony. It is already known, for example, that the layout of the mug shots and the type of photographs used can influence the identification made by a witness.

The center plans to explore the sociological impact of the recent Supreme Court ruling that a nine-to-three majority, instead of the former unanimous vote, is all that a jury needs in order to render a verdict of guilty.

In February the center will begin publishing a newsletter directed at lawyers. It will bring together information from all fields of social science pertinent to the practice of law. □

Annual Anthro Ritual

The annual meeting of the American Anthropological Association, held this year in Toronto, November 29–December 3, transpired with less controversy than it had in the past two years. Although the profession is still seeking both relevance and a conscience, the tones are quieter. The Distinguished Lecture, given by Southeast Asian scholar Georges Condominas, dealt with professional ethics. (Vietnamese-born Condominas's research on the Vietnamese had been used by the military, thus precipitating the continuing ethics controversy within the association.) Condominas feels that anthropologists should avoid sponsorship by special-interest groups and that they should become advocates, devoting their energies to meeting the aspirations and needs of the societies they study.

The proceedings also included a three-day, five-session "institute" entitled "Anthropology and Anti-Imperialism." Intermingled with the rhetoric was a number of outstanding papers, one of which, in retrospect, has special significance. In his address Australian Paul Coe pointed out that the aborigines, because of their small numbers, had been unable to exert real pressure on the Australian government to recognize aboriginal land rights, for example. Two weeks later, as part of an overall change in policy, Australia's new administration froze applications for land leases in the Northern Territory, an area with a high aboriginal population. This action was taken pending legislation to recognize aboriginal land rights.

In other areas:

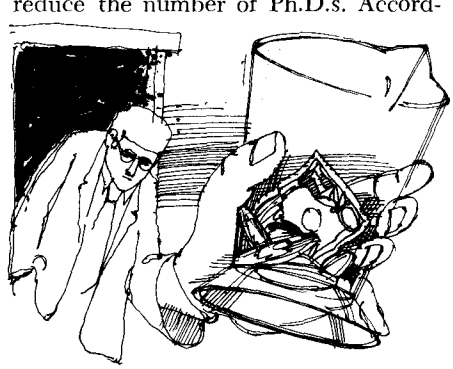
- Based on a global survey and field work in Indonesia, ethnologist Richard Franke concluded that the technological miracles of the "green revolution" are failing because the necessary concomitant social changes are lacking.
- In a special session the growing unemployment within the ranks was discussed, and the suggestion was tendered that graduates be encouraged to enter applied fields, such as community health centers. □

The following were among the resolutions passed by the anthropological association:

- Measures for the preservation of primates and their natural habitats;
- Support for the UNESCO Convention and other attempts to suppress the illegal trade in antiquities (*SR of The Sciences*, Oct. 1972);
- Condemnation of the killing of the two black students at Southern University in Louisiana;
- Support for Samuel L. Popkin, the Harvard professor who was jailed for refusing to reveal his sources, an action viewed by the association as a "grave threat to scholarly research";
- Rejection of all efforts to introduce into biology textbooks statements reflecting religious beliefs;
- Condemnation of the Vietnam War and all U.S. military activity in Laos, Cambodia, and Thailand. □

A Plethora of Ph.D.s

Rather than expanding research facilities to accommodate the large number of scientists without jobs, the solution to the Ph.D. glut may be simply to reduce the number of Ph.D.s. Accord-



ing to sociologists Jonathan R. Cole of Columbia University and his brother Stephen Cole of the State University of New York at Stonybrook, the rate of scientific advance would not be slowed by a reduction in the number of scientists. The Coles were testing a generally accepted notion that scientific discoveries by men of genius are based on the small findings of minor scientists.

In a study that examined the citations of significant recent papers in physics, the Coles discovered that great breakthroughs actually are influenced by the work of only a small group of elite scientists in just a few prestigious departments. Making more resources available to a smaller number of Ph.D.s, the sociologists believe, would ease the glut without interfering with the pace of scientific research. □

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PHYSICAL SCIENCES

Quasars

Since their discovery in the early 1960s, quasars, the brightest and most energetic bodies in the universe, have been treated as a distant class of astronomical objects. However, evidence that links quasars to galaxies has been accumulating at a rapid rate. According to Dr. Jerome Kristian of the Hale Observatories, some or possibly all quasars reside in the nuclei of galaxies. In fact, quasars may signal a definite stage in galactic evolution.

"The reason you don't see galaxies surrounding all quasars may be that the quasar's brilliance simply swamps the faint image of the galaxy," says Dr. Kristian. Although quasars are thought to be tiny in comparison with galaxies —a few light weeks as opposed to thousands of light years—they can be hundreds of times brighter than even the brightest galaxies.

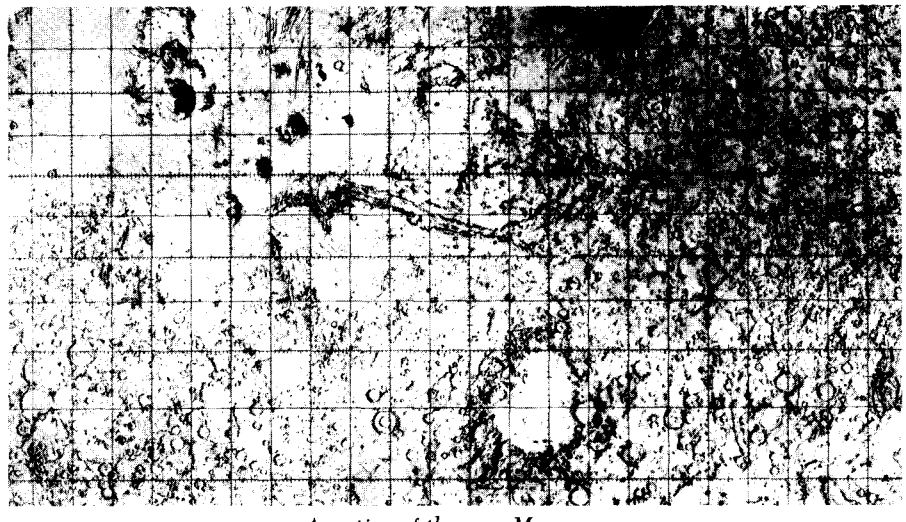
Evidence for placing some quasars in large clusters of galaxies has been presented in recent studies by such researchers as Dr. John Bahcall of the Princeton Institute of Advanced Studies and Dr. James Gunn of the Hale Observatories. However, more direct evidence of the link between galaxies and quasars has come from the study of two types of galaxies—Seyferts and *N* galaxies.

It has been known for some time that these two galactic types have small but extremely bright nuclei that look like "mini-quasars." Moreover, they have spectra similar to quasars, and, like quasars, they change brightness within the time span of a month. Quasars are generally brighter, but the brightest *N*-galaxy nuclei are about as bright as the faintest quasars. These similarities prompted Dr. Kristian's search for galaxies underlying known quasars.

The astronomer examined photographs of twenty-six quasars taken with the 200-inch Hale Telescope at Palomar Observatory in California. From earlier measurements of the image sizes of giant elliptical galaxies made by Dr. Allan Sandage of the Hale Observatories and from measurements of the image sizes of stars of various brightnesses, Dr. Kristian was able to predict for each quasar whether or not an underlying galaxy would be seen on the photographs. "The results were as predicted," he said. "Where you expect to see a galaxy, you do, and where you expect not to see one, you don't."

Dr. Kristian notes that "this association of quasars and galaxies makes quasars look a little less exotic and galaxies more so.

"We still don't know what is happening in quasars," he adds, "but it begins to look as though they may be a stage in galaxy evolution. If this turns out to be true, it raises many interesting questions. What fraction of galaxies go through a quasar stage? How long-lived is a quasar? What is its effect on the history of the galaxy? Is it an incidental thing that only happens under special conditions, or is it related in a fundamental way to the evolution of galaxies in general? □



A section of the USGS *Mars map*

Mapping the Red Planet

The first detailed map of the surface of Mars is now available from the U.S. Geological Survey (USGS). Compiled from some 1,500 photographs relayed from the *Mariner 9* spacecraft, this "shaded relief" map depicts the red planet at a scale of 1:25 million, or about one inch to 400 miles. It will be the first map in the USGS *Atlas of Mars* and will serve as a base for more detailed maps to follow. It can be obtained from the Distribution Section of the USGS, 1200 South Eads St., Arlington, Virginia 22202, for 75 cents. □

Copernicus

February 19 marks the five hundredth anniversary of the birth of the Polish astronomer Nicolaus Copernicus. Best-known for his rejection of the geocentric theory of the universe, a theory proposed by Ptolemy in the second century A.D., Copernicus believed that the earth revolved around the sun. This reversal of thought spawned what is called the Copernican Revolution, believed by many to have signaled the passage from the medieval to the modern world.

To commemorate the anniversary, NASA has launched an orbiting astronomical observatory called "Copernicus," and Congress has passed a resolution asking the President to proclaim February 19 as "Nicolaus Copernicus Day." Also, the National Academy of Sciences has commissioned Leo Smit, composer in residence at the American Academy in Rome, and Sir Fred Hoyle, the celebrated astronomer and novelist, to prepare a musical work in honor of Copernicus. The work is scheduled for performance in April, during the annual meeting of the academy. □

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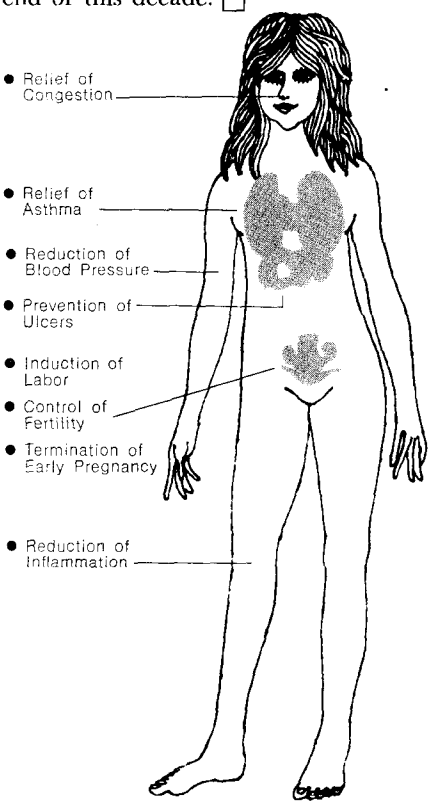
HEALTH & MEDICINE

The Panacea Pill

In an event that one day promises to be ranked in medical history alongside the introduction of antibiotics and steroid drugs, the Upjohn Company not long ago put the first prostaglandins on sale in England, almost forty years after they were discovered. Two synthetic varieties, Prostin E_2 and Prostin F_2-alpha, were cleared for marketing in the United Kingdom, a situation that is likely to occur in many other countries before the drugs make their way through the regulatory undergrowth of our Food and Drug Administration. These first two commercially available prostaglandins are being used for the termination of early pregnancy and the induction of labor at term. But waiting not far behind are twelve more prostaglandins in this family of remarkable, naturally occurring substances that regulate many of the body's activities. Hormonelike in their action, prostaglandins occur in minute amounts in the tissues of mammals and some lower animals. As drugs, they are expected to be the near-perfect birth-control pill, as well as the medical answer to treating ulcers, controlling inflammation and blood pressure, and relieving asthma and nasal congestion. All before the end of this decade. □



A Malignant Link

For years researchers have been patiently searching for chemical differences between normal and cancer cells that would allow them to detect an early malignancy and perhaps offer some means of attack. The discovery, at Rockefeller University, that cancer cells release a factor not formed by normal cells was viewed as so important that instead of waiting for journal publication—the normal route by which accepted medical information filters into the public's hands—the finding was made public in a series of maneuvers, one of which was to have cancer investigator Edward Reich spend most of one day late last year by the telephone in his New York office, answering questions. Reich's research, which was subsequently published a few weeks ago in the *Journal of Experimental Medicine*, centered on a type of cancer known as sarcoma that affects connective tissue. The malignant cells produce an as yet unnamed factor that interacts with a substance normally present in the blood (of man and animals). The result is the activation of still another blood substance, this time an enzyme that also is normally present but in inactive form. This enzyme, called fibrinolysin, causes some proteins, such as those formed in the body during the blood-clotting process, to break down into their component parts. One consequence of this degradation of protein is that the cancer is provided with nutrients for its sustained growth. Another is the modification of the internal environment to favor the growth and spread of the tumor.

Reich has already found a naturally occurring fibrinolysin inhibitor in one of the species of laboratory animals that have been exposed to sarcoma virus. The current speculation is that this inhibitor is part of the body's mechanism for control of growth and that it therefore might be important in natural resistance to cancer. □

Shhhh in Surgery

We expect surgery to take place in a properly hushed atmosphere, almost as if germs could penetrate the surgical mask should the voice behind it be raised above a whisper. Except for the reassuring slap of a hemostat deftly striking the surgeon's rubber-gloved hand or the muted sounds of perspiration being blotted from his forehead, the operating rooms to which we are made privy on numerous television shows are the quintessence of quiet. In reality, though, they could not be designed to be noisier. In a recent issue of the *New England Journal of Medicine*, a noise-detection experiment at Chicago's Michael Reese Hospital and

Medical Center is recounted. The decibel level in the operating room, the authors say, frequently exceeds that of a freeway and, more often than not, approximates that of a kitchen with a food blender churning full-tilt.

The loudest single noise recorded was the opening of a package of rubber gloves at eighty-six decibels—slightly louder than a diesel truck traveling fifty-four kilometers per hour would sound from fifteen meters away. The surgeon's conversation—which, the authors readily note, "frequently slipped off the track and involved other subject matter such as interpersonal relations, tennis, current ballgame scores, and even personal aspects of the patient"—ranged from sixty-six to seventy-two decibels, about that of a vacuum cleaner. Aside from approaching the maximum permissible noise exposure (ninety decibels for eight hours) of the U.S. Federal Occupational Safety and Health Act, operating-room noise is intense enough to cause constriction of blood vessels in the skin, dilatation of the pupils, as well as fatigue and irritation. And there have been reports that the anesthetized patient, although not aware at the time, does perceive the noises and conversation that occur during surgery.

"Surgery," Dr. Richard A. Shapiro and Theodore Berland conclude, "like other aspects of modern civilization, needs a 'Think Quiet' movement." □

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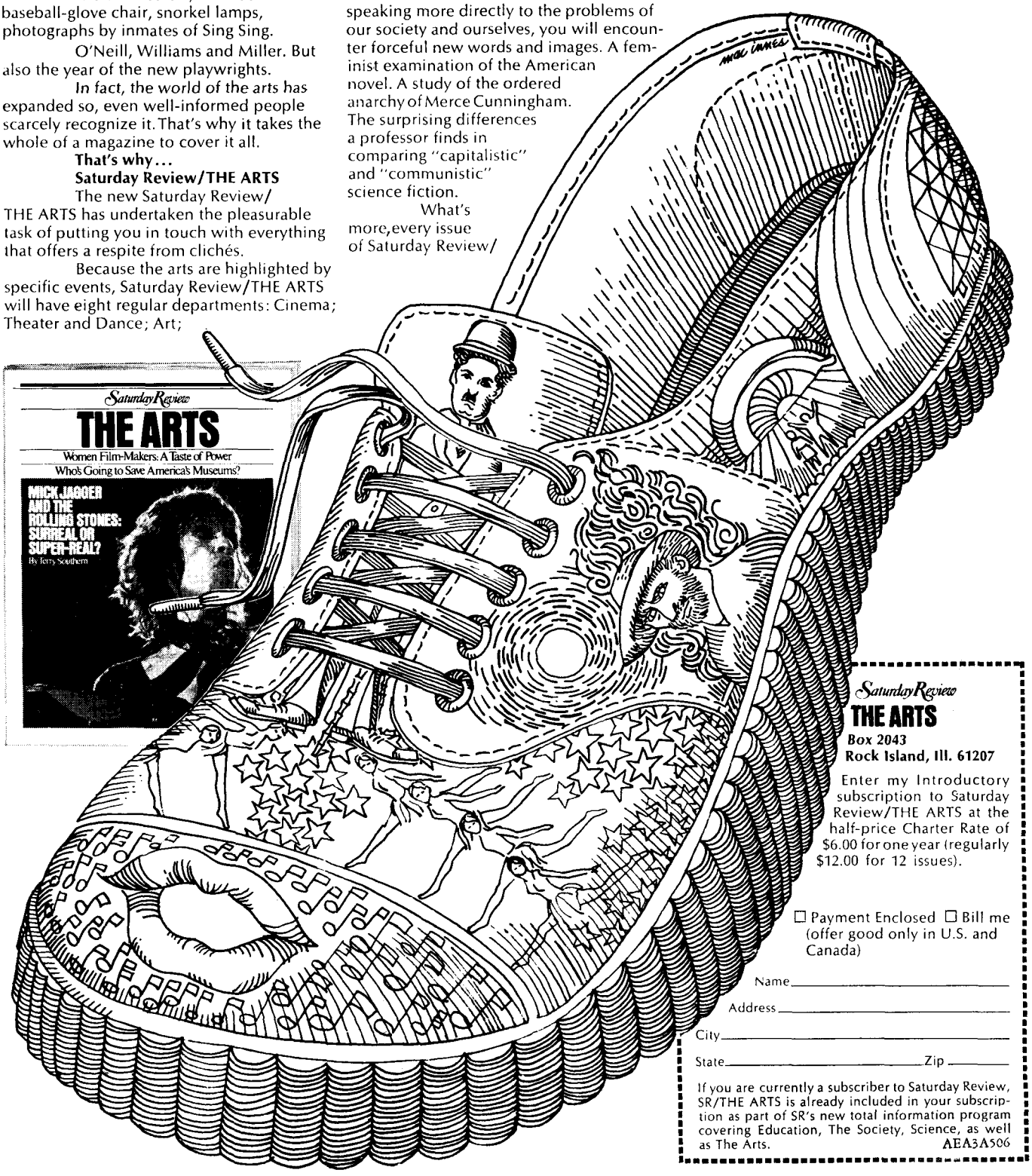
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TECHNOLOGY

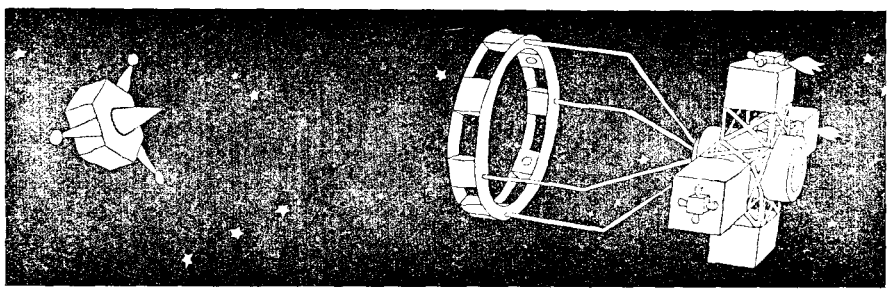
Lassoing Space Garbage

Cast-off rocket stages and expended satellites are beginning to clutter outer space, but getting rid of them is a tough housekeeping problem. "There are about 2,800 identifiable objects orbiting the earth, most of them 'space garbage,'" says Penn State aerospace engineer Marshall Kaplan.

Kaplan suggests a possible solution —a space retriever that could be shot up to a manned space shuttle and then sent to pick up space objects, under the electronic guidance of astronauts. A large ring on the retriever could be synchronized with spinning space objects, and metal arms extended from the ring's inner surface to make the capture. Retriever and captive would then be returned to the manned shuttle.

Kaplan's exploratory study was funded by NASA, which wants to clean up frequently used low-altitude orbits for future space travel and research missions. While unusable space objects could be junked, NASA is hopeful of retrieving nonfunctioning satellites, repairing them on board the shuttle, and reinserting them in orbit. □

Collecting space garbage in the 1980s.



Reading the Plumes

Laser science now offers a new environmental tool—detection of dangerous air pollutants from a distance. NASA experimenters from Langley Research Center, cooperating with the Environmental Protection Agency, recently succeeded in remote sensing of toxic sulfur dioxide emissions from industrial smokestacks.

Until now exhaust plumes had to be sampled from within the smokestack itself, then chemically analyzed with nearby instruments. The portable laser now under development has the advantage of measuring exhaust plumes in the atmosphere from a distance of up to one kilometer (3,300 feet). This would assist regulatory agencies in independently monitoring a large industrial area to pinpoint plants violating allowable pollution levels.

In a series of field tests conducted at a power plant in Asheville, North Carolina, the NASA investigators used a powerful, telescope-mounted ruby laser. In detecting the presence of sulfur dioxide, this laser utilizes Raman scattering, a technique similar in principle to microwave radar.

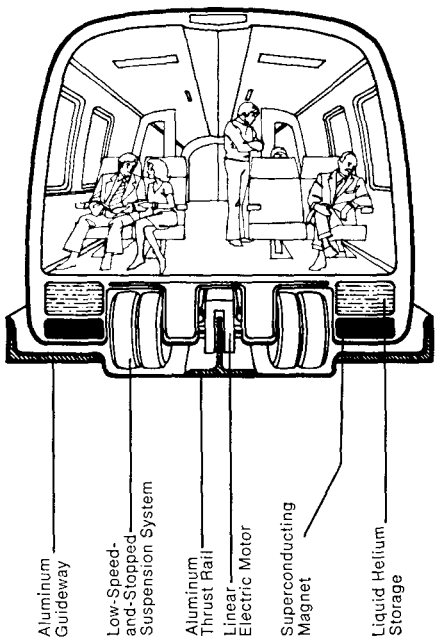
Dr. S. H. Melfi, in charge of the Langley project, admits that the Raman laser technique has definite limitations at this stage. It can be used only at night, when background light does not interfere, but is still valuable since some industries emit pollutants under cover of darkness. The intense laser necessary for Raman scattering also increases radiation hazards. Furthermore, since the Raman technique is not sensitive enough to low pollutant concentrations, it is practicable only for monitoring pollutants at their industrial source.

The remote-sensing laser shows promise of detecting other industrial pollutants, among them nitric oxide. □

Flying Trains

According to scientists at Stanford Research Institute, tomorrow's trains may be air-borne, "flying" a foot above the ground at speeds up to 300 miles per hour. These scientists are investigating a magnetically levitated transportation system (MAGLEV) that employs superconducting magnets to float vehicles above an aluminum guideway.

An experimental vehicle—a small sled, weighing 600 pounds—recently traveled 250 feet, floating 2½ inches above the test track. Magnets on its lower surface caused currents to flow in the guideway below. These currents produced magnetic fields that repelled



Proposed MAGLEV *vehicle*

the magnets on the vehicle, thus pushing it off the ground.

The superconducting magnets must be chilled to −405°F. in a bath of liquid helium. At this low temperature resistance to electric currents in the magnets' coils virtually disappears. Once a current is introduced, it persists indefinitely, without further input of power.

The propulsion of suspended vehicles is obviously limited to systems not utilizing traction. Thus, a top candidate for such systems is the linear electric motor, which provides the needed thrust yet is pollution free. Last September the Japanese levitated a four-man vehicle, combining superconducting magnets with a linear electric motor.

MAGLEV's competition is a high-speed vehicle that rides on a cushion of air. The tracked air cushion project, underway since 1966, has already entered the hardware phase: a 51-foot-long, 65,000-pound prototype is now being tested.

The Department of Transportation has spent $13 million on the tracked air cushion project, compared with only $600,000 in the past two years on magnetic levitation. However, it expects to spend as much on developing a magnetic test vehicle as it has on the tracked air cushion system. Ride characteristics and cost comparisons will then be analyzed to determine whether MAGLEV or tracked air suspension will be the prime candidate for high-speed ground transportation in the 1980s. □

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BOOKS

Breathing Life

BY ELIOT FREMONT-SMITH

THE ARMIES OF THE ANT. Based on the experiences of Charles L. Hogue. Edited by Alfred Meyer. Illustrated. 234 pages. World Publishing. $12.50.

Two years ago Charles L. Hogue, senior curator of entomology at the Natural History Museum in Los Angeles, took up winter residence in a small wooden research station in the rain forest of Rincón de Osa, a Pacific coast peninsula of Costa Rica. There he studied—immersed himself in—the extraordinarily rich and varied vegetation and animal life of the tropical rain forest, took thousands of feet of close-up color motion pictures, and talked his thoughts and feelings into a tape recorder. The result is a remarkable, beautiful, and deeply affecting book, the second in the American Museum of Natural History's New Explorers series.

The basic idea of the series has been to put a seasoned biologist rather than a camera crew behind the camera. Nature, as the editor of the series notes in a foreword, has its own rhythms, which are not at all the same as those of human economics and camera crews; moreover, a biologist is clearly apt to be more able and willing to stay "on location" for a long enough period of time to come away with more than superficial footage. And besides, "the organizers of the series have found that it is far easier to teach a biologist to use a motion picture camera than it is to teach a cameraman biology."

Be that as it may, the numerous pictures in this book, color stills from the films, are stunning. Yet it is not an easy book to define; it is more a personal testament (even a travel book) than it is a scientific treatise. There is more awe and wonder in it than there are "findings"—though these, too, are plentiful. It evokes a whole and intense ecological drama (in which the army ants play only a role—the title is misleading); Charles Hogue immersed himself in this drama, and through this book we are also immersed in it. A romantic notion, perhaps—the naturalist *in* nature—but also a corrective to the odd idea that science is not a romance.

"I expected to have a very poor day with much rain, but it didn't materialize. Instead, the morning was one of the most beautiful mornings I have spent in the forest. It is late March. I was up early and saw heavy clouds over the Golfo Dulce bringing me a beautiful golden sunrise. For some reason, the forest was unusually fresh and crisp. I got out and down on the tinamou trail early—probably about eight-thirty or nine. I can't really put it into words, but for some reason everything was different. It was cooler, for one. I read the thermometer about eight o'clock, and it was sixty-nine degrees—probably cooler because of the heavy rains two days ago. I think everything was washed clean and made new. The air was freshened by the coolness and by the moisture, and the animals were stimulated. Fog shrouded the valley floor, and the air had a slight mist in it which gave it a tangible substance. I was able this morning to take advantage of the beauty of the forest more than any time before. I walked past plants dripping wet from the dew and mist, and I saw leaves translucent through their moisture, the sun shining brightly behind them. I saw the bark of the trees covered with moss and, for the first time, lichens exposed to the sun. Everything seemed to be made ready for me. . . ."

A katydid leaving her nymphal skin, photograph from The Armies of the Ant.

And he goes on, in this middle chapter, to talk about the coolness of the forest (the steaminess is the heavy dew evaporating), the butterflies ("their beautiful blue wings flashing across the clearing and through pools of light"), the misnaming of a type of tree frog (the scientist was color-blind), another tree frog, whose belly is transparent so that one can see its internal organs functioning, the feelings of pressure to photograph and take notes and keep records when he would rather simply see and experience and not talk about it but keep these moments private, to himself.

That is one mood. Another is equally human: "I continually sustain dozens of insect bites and stings on my legs. One evening I counted over one hundred and seventy. It is a constant trial and completely aggravating. . . . I suffer repeated fits of itching and scratching. When I put my boots on in the morning my feet are sore and begin to itch and hurt. I pull my pants legs down over my legs, and my legs become irritated and start to itch and hurt. It just goes on and on, and I get sick of it. I'll have to say sometimes I get pretty tired of the monotony of this place, too. I think it is starting to get to me. I'm in a hole in the jungle, and all I can see are green trees and the ground and the sky, all of which engulf me."

It is, thus, a book of moods, but it is also a book crammed full of acute observations that come through all the senses. "You feel the life around you," Hogue writes early on. "The things around you are alive. You breathe in life; all your senses are perceiving life." And the categories—animals, plants—begin to meld into each other; interdependence and symbiosis become the pulse and throb of a million different but intertwined life cycles. The Cecropia is a weed tree; it is also the home of Azteca ants. But the relationship is symbiotic: the ants protect the tree, rushing out in fury to attack anything—animal or another plant, such as the parasitical epiphyte vines—that disturbs the tree. Nor is there a clean line between living and dead: the decomposing branch is as much a part of the ecosystem as the living insects that help break up its cellulose to return the nutrients to the ground. Noisy toucans, luminous beetles, click beetles (they can snap their backs to right themselves), orchids and orchid bees,

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bag worms, caterpillars, spiders that disperse themselves by floating in the air on strands of silk (a process appropriately called "ballooning"), maggots (one lodged in Hogue's foot), elegant butterflies, spiny palms—all of these are observed and experienced and wondered about in these pages.

And then there are the army ants, which in life are quite unlike the scary hordes in Hollywood melodramas. For one thing, on a raid their fastest pace is about forty yards an hour, so that, with the exception of insects that don't fly well, there is hardly an animal that can't get out of their way. Their movements are more analogous to the principles of hydraulics than to any human army. But they are determined little creatures and completely fascinating, and among the more absorbing parts of this book are Hogue's speculations on how they are organized, how their activities are so controlled outside the bivouac, and how the integrity of any particular colony (numbering up to half a million ants) is so tightly maintained.

The book ends, not with Hogue's return from the rain forest, but with his sitting in a jungle pool, marveling at the poetic motion of a snake, warding off the nipping fish, immersed in "this forest cathedral," feeling the sharp gravel on his backside, talking all of this into his tape recorder, and enthralled. □

A Crumbling Castle, A Busy Countess

IN SEARCH OF DRACULA: A True History of Dracula and Vampire Legends. By Raymond T. McNally and Radu Florescu. Illustrated. 223 pages. New York Graphic Society. $8.95.
THE TRUTH ABOUT DRACULA. By Gabriel Ronay. Illustrated. 180 pages. Stein and Day. $7.95.
A DREAM OF DRACULA: In Search of the Living Dead. By Leonard Wolf. Illustrated. 327 pages. Little, Brown. $8.95.

BY GENEVIEVE STUTTAFORD

Stalking vampires in Transylvania probably sounded like a nifty notion, so nifty, in fact, that several authors thought of it at once (not really so surprising a coincidence, considering that Radu Florescu, Gabriel Ronay, and Leonard Wolf were all born there)—but what a pity they took it all so seriously. Since this is the seventy-fifth anniversary of the novel that started it all, Bram Stoker's *Dracula*, the timing must have seemed just right to go Stoker one better (everybody wants to challenge a champ) with a horror story

that connected the real fifteenth-century Balkan prince named Dracula with the classic imaginary vampire. And what could possibly be expected to come out of such a silly idea?

Still, in the hope that an idea that didn't work out might be just as intriguing to a reader as one that did, Raymond McNally and Radu Florescu forge ahead like intrepid backpackers determined to reach the high country before sundown. Not until the end of *In Search of Dracula* do they concede (somewhat sheepishly) that their Count Dracula, as terrifying as he may have been in his own right, is at best a minor curiosity and interesting only if myth and fact can be glued together. Rather disarmingly they write: "We must confess that we have not entirely succeeded in bridging the gap."

It's remarkable, all the same, how they do make do. Wolves howl in the background (standard movie suspense) while McNally and Florescu sleuth around the Carpathian Mountains, following Stoker's clues—which are not very accurate, as it turns out—all without seeming to realize what a totally wacky escapade it is. And, indeed, they do find a castle, or at least a few crumbling walls—which the Rumanian government at this very moment is restoring as a tourist attraction.

Whenever the authors aren't self-consciously trying to write a mystery scenario and get down to the book they're stuck with, they prove to be inexhaustible researchers, what with tracking down what seems to be every document extant and talking to virtually all the peasants in the district (themselves no slouches when it comes to spinning a hairy tale)—and in *In Search of Dracula* they've pieced together an extraordinary amount of information about the count. His name was Vlad Tepes ("the impaler"), and he inherited the title Dracula from his father, who had earned the Order of the Dragon (also translated as *devil*, or *dracul* in Rumanian) for combat against the Turks. Vlad was either a hero (cruel but just) or a villain (just cruel), depending on which sources one believes; in any case he was apparently a rather ghoulish figure who got his kicks from impaling his enemies. But, unquestionably and alas, he was no vampire.

That connection actually more likely fits an Austro-Hungarian noblewoman named Countess Elisabeth Bathory (1560–1614), whom McNally and Florescu unearthed along the way; a violent and obviously mad lady, she bathed in the blood of virgins. But she's not quite the vampire the authors had their hearts set on, and they pass her by in three pages and several illustrations.

Gabriel Ronay, on the other hand, is not about to let the reader off quite as easily, and, for whatever reasons, in *The Truth About Dracula* he's out to pin the rap of vampirism on women. His interest in the Dracula legend grew out of a curiosity about the *a* ending (could it be feminine?), but, as he found out, there's nothing especially sinister about the masculine genitive ending in the Cyrillic alphabet ("son of Dracul").

Yet history has a way of accommodating a variety of inclinations, and it

Genevieve Stuttaford is associate book review editor of SR.

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1715. Cognac begins.

The world is discovering cognac.

At the same time, Jean Martell arrives in Cognac Country.

He is beguiled by the distilling of brandy.

By 1728, 27,000 barrels of cognac have been exported.

That was 243 years ago.

Since then, it is difficult to separate the history of cognac from that of House of Martell.

In fact, there has been no other occupation for anyone in the Martell family except that of creating fine cognac.

Which is probably the reason Martell cognacs are the largest-selling in the world.

Martell. Taste history.

☆☆☆ – V.S.O.P. – CORDON BLEU

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The Curious Legend of La Dame Blanche

Long, long ago, in the Bordeaux region of France, there lived a handsome young Count.

The estate on which he lived had a truly remarkable vineyard, from which came one of the finest wines in all of France. This wine was treasured throughout the land and was a source of great pride to the young aristocrat.

The people all loved him, for he was very good to them, and the fine wine he produced brought prosperity to them all.

However, they were concerned about one thing.

He had not yet found a wife.

One day, the Count decided to take a holiday, and he journeyed to Morocco. There he met a beautiful Moorish princess with dark mysterious eyes and black silken hair.

And skin the color of dark topaz.

She was, he thought, the most beautiful woman he had ever seen, and he fell hopelessly in love with her. And she with him. And so they were married.

When the news of the beloved Count's marriage to a dark-skinned woman reached the people, they were dismayed. And when he brought her home, they turned their backs on her. Why couldn't he have married one of his own kind?

Despite this, the pair lived happily together until the Count died. Then, his loving wife did something that shocked everyone.

She came to the funeral dressed in white... the color of mourning of her native land.

No one in France had ever worn anything but black for mourning. Oh, she had strange ways, this dark foreign woman.

The bereaved Countess wore nothing but white for the rest of her life, for she had loved her husband very much. So much so that, in his tradition, she continued caring for the vineyard. Which, in turn, continued to produce the superb wine.

She was really a very kind woman, and, like her husband, treated the people well. Slowly, they began to accept her. And they learned to love her as much as they had the Count.

Later, when she died, they all came to her funeral to honor her.

And they came dressed in white.

Now, here is the curious part of the story.

Ever since the death of the Countess, on certain mornings at dawn, a strange white mist drifts across the meadow and surrounds the Chateau.

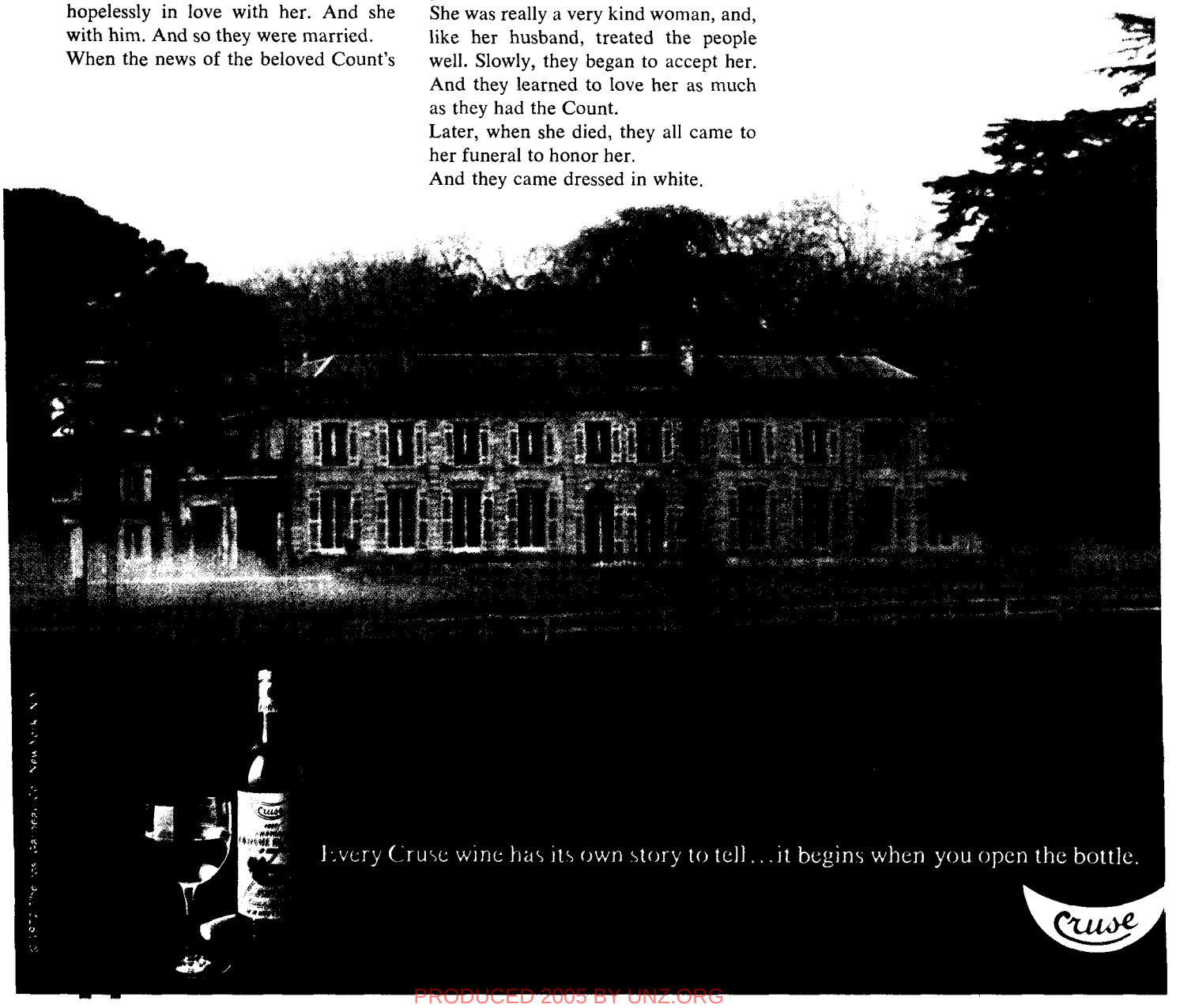
And the people seeing this phenomenon, say, "La Dame Blanche has returned". So when the white mist appears, the people are happy to be reminded that La Dame Blanche remembers them.

Today, the famous Cruse family occupies the Chateau. And their wine, now called Chateau La Dame Blanche, is still among the finest in all of France. As is every wine that bears the Cruse crescent. Each with its own special story to tell.

Happily, the spirit of La Dame Blanche still prevails.

At the Chateau near Bordeaux.

And on some of the finest tables in the world.



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Contemporary portrait of Dracula.

was inevitable that Ronay, too, would stumble across Countess Elisabeth. And she suits him just fine: "In exploring the psychology of lesbian aberrations—one of which is vampirism—the link between love and pain, the most fundamental in the whole range of sexual psychology, is of crucial importance." The link, he goes on, sounding just a bit antiquarian, "is at the root of that love of cruelty which is, according to Professor Krafft-Ebing [*in Psychopathia Sexualis*] and many leading Freudian psychologists, so marked in women." In other ways, though, the countess was in his estimation a perfectly "normal" woman: "her bloodlust," he writes, "did not interfere with the major emotions in every woman's life—motherhood and true love for the father of her children." And thus having established, to his satisfaction, the psychology of women, Ronay proceeds to relate Elisabeth's bizarre activities, condensing no detail and leaving nothing to the imagination in this altogether vulgar, distasteful, and disagreeable book. (It is interesting to note that whereas McNally and Florescu estimate the number of Elisabeth's victims to have been between thirty and fifty, which is bad enough, Ronay has come up with the figure 650.)

After Ronay it's almost a relief to turn to Leonard Wolf's *A Dream of Dracula*, although that, too, is curious and disturbing in another way: the theme is how odd the author feels about writing it. The book exerts a peculiar fascination, a voyeuristic allure of eavesdropping on a lively, scholarly, sensitive, and sensuous mind roaming over its own confusions. Wolf is interested not so much in vampires or the "undead" for their own sake as he is in our primordial urges and fascinations that created stories and legends about them. He looks in the mirror at his wrinkles, notices—at the age of forty-eight—that his vitality is waning, and feels that he, too, wants to defy God, to say "No!" The undead have made a bargain, albeit a bad one, but they have opened the possibility of an alternative, a kind of immortality that is both seductive and repulsive. □

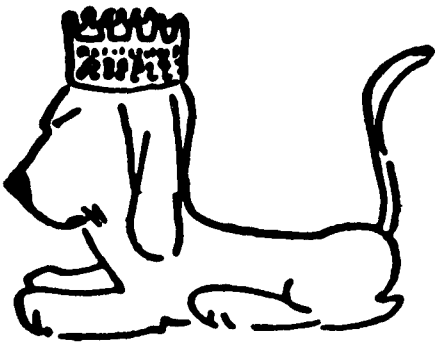
Art and Ecstasy

HOW TO RAISE A DOG IN THE CITY AND IN THE SUBURBS. By James R. Kinney, with Ann Honeycutt. Illustrated by James Thurber. Simon & Schuster. Revised edition, paperback, $1.95.

BY MAXIMILIAN D'ASTICOU

I shall be frank. This is the best guide book about dogs ever written. In the first place, it has the proper attitude: it is respectful. In the second place, it tells a great deal that humans really ought to know about proper behavior toward, not to mention vis-à-vis, us. For instance, how to be grateful for our affection. This is above and beyond the usual "useful" information about when to get a dog; skin blemishes, worms, fits, and other embarrassments; feeding and menu preparing (personally, one-half Alpo and one-half all else, barring ketchup, does just fine); pregnancy and motherhood ("it is conceded that females make more intelligent mothers than males"); grooming (ecstasy, blemished only by the incredible fact that it stops too soon); and training (same problem: most difficult to train well because their attention spans are so short); accidents around the home (a Ralph Nader Alert: certain plastic toys, made deliberately delectable for chewing, wreak havoc on the old schnozzola; I myself remember a particularly mortifying contretemps with a green plastic duck that resulted in my not being able to see frontwards for several days); and such like. In ad-

Maximilian D'asticou, long, low, and raised in Wiscasset, Maine, has resided in the cities and suburbs of Brooklyn, Boston, and San Francisco.



SR. RECOMMENDS

A rotating selection by the book review editors of ten particularly notable new and current books of general interest, arranged alphabetically by title

THE BEST AND THE BRIGHTEST. By David Halberstam (Random House, $10)—A thoroughgoing and provocative analysis of the uses and abuses of power by the extraordinarily able policy-makers of the Kennedy and Johnson administrations, who went to Washington to build a Camelot and left behind a country trapped in unwanted war and divided against itself.

FIRE IN THE LAKE: The Vietnamese and the Americans in Vietnam. By Frances FitzGerald (Atlantic–Little, Brown, $12.50)—With its intelligence, ability, and fine sense of Vietnamese culture and history, Miss FitzGerald's book becomes one of the best yet written about our involvement in Vietnam.

THE FRED ASTAIRE & GINGER ROGERS BOOK. By Arlene Croce (Outerbridge & Lazard, $9.95)—An intelligent text and nostalgic photographs combine in an act of homage to the team whose grace and style have become film landmarks.

THE GREAT BRIDGE. By David McCullough (Simon & Schuster, $10.95)—The fascinating story of the construction of the Brooklyn Bridge, whose dramatic engineering was matched only by the melodrama of political chicanery that attended it.

HARRY S. TRUMAN. By Margaret Truman (Morrow, $10.95)—A frank and openly affectionate biography of the former President by his daughter.

THE MAKING OF A PSYCHIATRIST. By David S. Viscott (Arbor House, $8.95)—An exceptionally candid, warm, and compellingly readable account of a young doctor's training and early practice in psychiatry.

THE POLITICS OF A GUARANTEED INCOME: The Nixon Administration and The Family Assistance Plan. By Daniel Patrick Moynihan (Random House, $15)—This well-written, detailed account of the fate of the most far-reaching social legislation proposed since the New Deal provides a rare inside view of the workings of government and the pressures of politics.

THE SUNLIGHT DIALOGUES. By John Gardner (Knopf, $8.95)—The author of *Grendel* takes on the complex texture of an American small town, the motif of medieval romance, and the weighty themes of freedom and entropy in his most important novel to date.

TRANSPARENT THINGS. By Vladimir Nabokov (McGraw-Hill, $5.95)—A new brief novel, whose underlying theme is the juxtaposition of art and death, by the master of literary mirrors.

VIRGINIA WOOLF. By Quentin Bell (Harcourt Brace Jovanovich, $12.50)—A revealing biography of Virginia Woolf by her nephew, offering the fullest account yet of the Bloomsbury novelist, her circle, and her troubled life.

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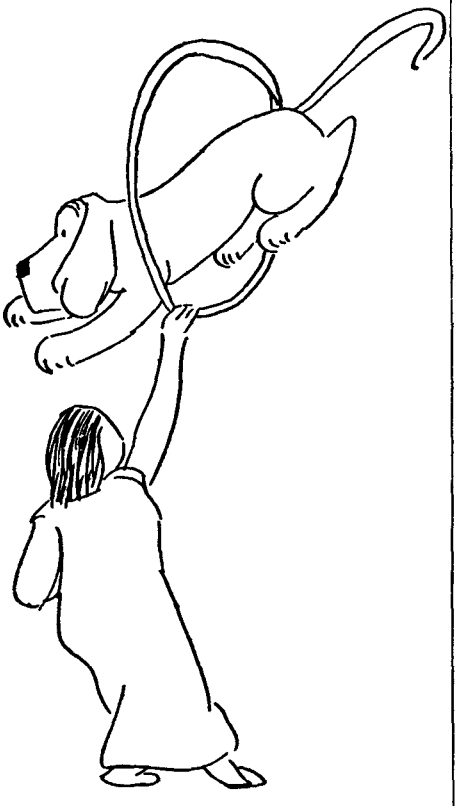
dition, it really does understand us in terms of habitat: in the city and in the suburbs, as the title says, and also in the country. Essentially, we like the country best. Also, essentially, we don't give a damn. What we do give a damn about is the absence of our loved ones.

Drawing by James Thurber, from How to Raise a Dog in the City and in the Suburbs.



And this brings me to the shortcomings of the book. First, the drawings by James Thurber—though, of course, delightful in their way—portray a most grossly . . . well, swollen shape of dog. A proper dog should be long and shapely and close to the ground. The dachshund—simple candor dictates my opining—is a particularly handsome breed to which many of my acquaintances could aspire to advantage. There is a dachshund on the cover of this book along with an affable standard poodle and a pair of over-eager hirsute spaniels; but for many readers one of the pleasures of the book will be Thurber's illustrations: his moods are right; his beasts are lumpy.

The sex-life chapter starts out well: "With all his development and civilized airs, the dog's attitude toward love remains exactly as it was in 8000 B.C. He still considers love simple. He still insists that love is a matter of physical attraction and gratification, with no time lost in between. . . ." And it has some sensible advice about what may happen when lovers are not plentiful and what humans should do about it (nothing). However—and this is a male point of view, though from my own observations gender here makes little difference—the true enticement of the human ankle or shin is not fully appreciated. I'm not sure why this is so, but the most irresistible ankles tend to belong to the most embarrassable people. I myself have many times been told to stop what I was doing while at the same time being patted encouragingly on the head. All I can say is I know a tease when I spot one; but more objective discussion of this phenomenon (is it the mating instinct or the hunting instinct?) might have been enlightening.

As for absent loved ones—well, some of us give "presents" for them to discover on their always tardy return. This is, of course, a mixture of love and anger. That humans react only angrily is one of the great mysteries of life. Since it is a mystery, we shall continue to explore it.

On most else this latest revision (the book was first published in 1938) is superlative. Attack dogs—a strictly human perversion, these canine Uncle Toms of our troubled times—are, happily and with dignity, not mentioned.

Essentially, what we like best is being paid constant attention to (food is an especially efficacious way) and worried about and generally appreciated and obeyed and dozing in the sun, which is what this remarkable and long-lived book so beautifully and acutely understands. □

SHORTER REVIEWS

MATHEMATICAL THOUGHT FROM ANCIENT TO MODERN TIMES. By Morris Kline. Illustrated. 1,238 pages. Oxford University Press. $35.

Morris Kline, professor of mathematics, Courant Institute of Mathematical Sciences at New York University, has produced in this enormous (1,238 close-typed pages) book what must be the definitive history of mathematical thought. Clearly written and handsomely produced—the formulas and charts are exactly where they should be in relation to the text—the book begins with the Babylonians and works right through to the opening decades of this century, the greater bulk of it devoted to what has happened since 1700. Kline's achievement, apart from the formidable compilation such a task requires, is to make this abstract discipline come alive with a sense of organic growth: we see the personalities, the societies, the false starts, and the patient building up of a body of knowledge now so complex that it overwhelms the layman. He is particularly concerned with the relationship between mathematics and the physical sciences, skillful at detailing the steps leading to a breakthrough in concept (those moments when everything seems to fall into place), and equally adept at sorting out the sheer bulk of information that has developed in the last two centuries. Despite Kline's remarkable clarity, his book will be necessarily heavy going (and perhaps impenetrable) for the general reader, but for anyone with a background and interest in mathematics it is an important event—probably the most comprehensive account of mathematical history we have yet had.

THE DEATH OF PROGRESS. By Bernard James. 166 pages. Alfred A. Knopf. $5.95.

Bernard James, in this tedious, murky book, appears to be one of those people who fear we made a wrong turning after the Renaissance. The Age of Reason has become a self-defeating trap of "hyperrationality," God having become "our belief in endless materialistic progress," and his altar an obsessive efficiency. Now that substitute deity is dying, too, causing a good deal of the malaise and turmoil we see around us —technological overkill on the one hand, a retreat from consciousness on the other. Nor are things likely to get better. "We may anticipate a bewildered and panic-ridden immediate future and a series of frantic and largely ineffectual responses to our problems. We may also expect increasing sympathy for abrupt totalitarian solutions." What, then, can be done? Nothing less than a major overhaul, a "consciously managed world culture" that depends heavily on a shift in contemporary education. A good many of the ideas in this book are familiar, but James, a professor of anthropology at the University of Wisconsin, draws on anthropology, philosophy, ecology, and breezy contemporary observation to make them even more muddled and lofty than usual. (Nor does he feel the need to discuss the political implications.) This is a pity, because the ideas are obviously important, and James has some interesting things to say about them, but the shrill high seriousness and density of approach just compound an already difficult subject. This is a book meant to be visionary that stops short at pedantry.

NOBODY EVER DIED OF OLD AGE. By Sharon R. Curtin. 228 pages. Atlantic–Little, Brown. $6.95.

Today there are 20 million Americans over sixty-five years old. Sharon Curtin, who is not, spent two years talking and listening to some of them to "learn just what it means to be old in America." Too often what it means, she discovered, is loneliness on a fixed income,

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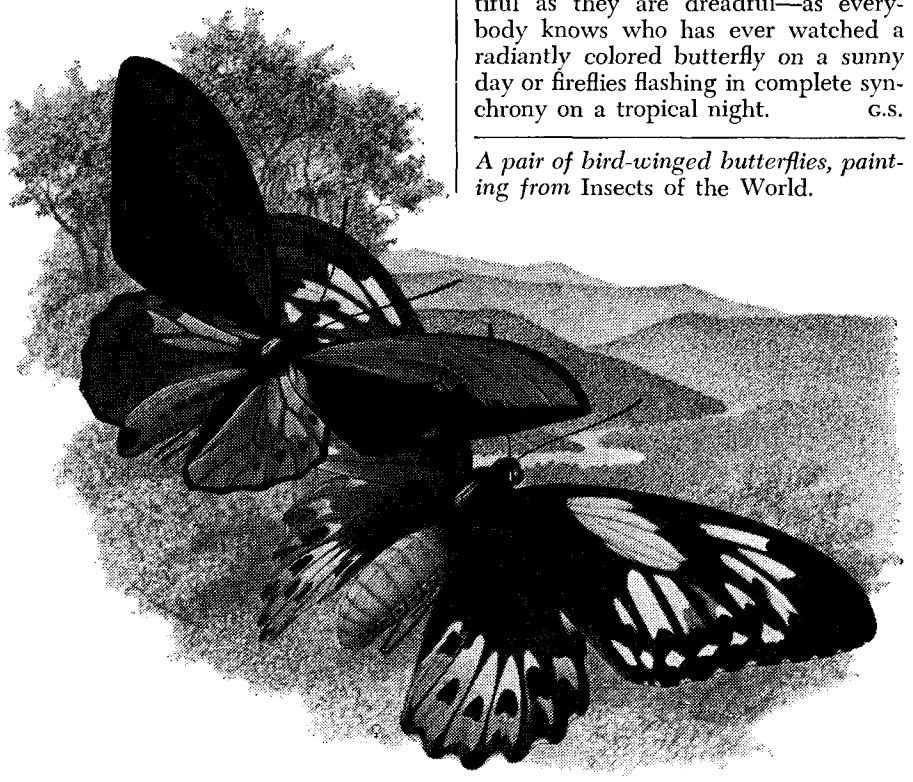
helplessness before bureaucracy, and a spiritual shelving by a society that worships youth. Her book is not so much a sociological treatise as a personal exploration, drawing on her childhood experiences in a small-town extended family ("I sometimes have a dreadful fear that mine will be the last generation to know old people as friends"), her years spent as a nurse, and a few investigative field trips (living in a pensioners' hotel, visiting a retirement village). Because she is more interested in the experience, rather than the statistics, of aging, she leans heavily on stories of old people she has known: a "bag lady" who carries all her possessions with her wherever she goes, a neighborhood harpy with one of the slickest shoplifting techniques in New York, two aging tramps who have an agreement to smother whichever one becomes helpless first, a retired schoolteacher raging against the mindlessness of a nursing home where patients are at the mercy not merely of the nurses

Another World

INSECTS OF THE WORLD. By Walter Linsenmaier. Illustrated. 392 pages. McGraw-Hill. $25.

As sumptuously produced as an art book (160 full-color paintings and hundreds of drawings), scientifically precise, and written with poetic grace, *Insects of the World* presents a unique entomological survey course by the world-famous Swiss naturalist-painter Walter Linsenmaier. The book is intelligently organized for maximum clarity—logically working through the stages of anatomy, growth, breeding, migratory patterns, behavior, etc.—as it vividly explores a varied, complex, and astonishing "other world." The most adaptable of creatures (as pesticide manufacturers have discovered to their dismay), insects have been around for approximately 350 million years and in such variety that it's impossible to establish how many species exist. To date three million species have been taxonomically classified (as compared with 67,000 vertebrate species), but, given the rate of insect evolution, this work will never be completed. While cockroaches have evolved in a direct line with only minor variations, the pesky fly alone has been classified into 100,000 species (more than 100 families).

Insect behavior is, in its own way, as endlessly fascinating as human behavior; most is known about the social insects, because they are, of course, the most accessible for study. Individual ant colonies have been observed for as long as eighty years; ant societies may inhabit areas of several thousand square miles and contain more than one million members. Among the most dangerous insects are the disease-carrying mosquitoes that have plagued humanity at least since Roman times (20,000 Frenchmen died of malaria during the construction of the Panama Canal). Yet insects can be as wondrously beautiful as they are dreadful—as everybody knows who has ever watched a radiantly colored butterfly on a sunny day or fireflies flashing in complete synchrony on a tropical night. G.S.



A pair of bird-winged butterflies, painting from Insects of the World.

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Wit Twister No. 303 (Reprise)

Note: The editors apologize to Mrs. William H. Doughty of Winnetka, Illinois, who was the author of Wit Twister No. 303 (SR of The Sciences, January). *The verse was incorrectly ascribed to Arthur Swan. To add insult to injury, the second line of Mrs. Doughty's verse was dropped. The verse should have read as follows:*

Whilst, Autumn Wind, thou — — — — — — sky and land,

Thou — — — — — — — me outside once more to see

The — — — — — — — of the leaves, before thy hand

Has made them — — — — — — — in each flaming tree.

O sad — — — — — — —: that dancing they must fall

And lie like motley garb the — — — — — — — sold

To be the soldier's — — — — — — — when the pall

Of battle-smoke was mixed with frost and cold!

Answer on page 79.

FRASER YOUNG LITERARY CRYPT NO. 1539

A cryptogram is writing in cipher. Every letter is part of a code that remains constant throughout the puzzle. Answer No. 1539 will be found on page 79.

SM GJM QXIF ZL CXJGIVYQY SVQD QDM OIGVPMYQ TGNMY QDGQ VCCXJGIVQL SVII YOXVI XKJ IXXWY.

I. O. YCVQD

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but of an up-and-at-'em social director whose idea of a good time is a first-grade Halloween party with cupcakes, cider, and grotesque masks for her wheelchaired victims. These stories, and many others, are told with anger and always with compassion but never with sentimentality. Curtin believes that motivation for any real change must come from old people themselves (who account for an annual $65 billion in business and who vote in great numbers), and she discusses the possibilities of consciousness-raising groups, experiments with types of extended families, and the guaranteed income (which would not only provide security but eliminate the agency nosy-parkers). But her overriding concern is with the attitudes our society has formed toward aging, and her lucid, intelligent, often moving book is meant to serve, at least in part, as a reminder that those we now consider a "problem" will one day be ourselves.

RATTLESNAKES: Their Habits, Life Histories, and Influence on Mankind. By Laurence M. Klauber. Illustrated. 1,533 pages. University of California Press. $50. Generally greeted as the definitive work on rattlesnakes when it was originally published in 1956, this superb two-volume compilation of everything that is known about the dangerous reptile, both in science (clarified here with photographs and drawings, morphological tables, statistical charts on geographic distribution, and other aids) and in popular belief (current and traditional folklore), is now expanded to cover species that more recently have been identified and classified. In addition, other pertinent information has been added, such as the most recent medical findings on the effects (and treatment) of snakebite, guidelines for protection in the wilderness (chemical repellents, we are told, are worthless), techniques for handling rattlers in captivity—in other words, *all* the data available. While this collection, in every sense a major scientific accomplishment, is not intended for the casual naturalist, the book, at the same time, is so enormously readable and written with such enthusiasm, that, on balance, rattlesnakes take on a fascination a lay reader might never have anticipated. The author, who is now deceased, was a professional engineer but obviously dedicated to his avocation. For forty years he served as a consulting curator of reptiles at the San Diego Zoo and, even more remarkable, successfully bred rattlesnakes in the basement of his home—that last a personal indulgence for the tolerance of which, incidentally, he dutifully thanks an understanding wife in the dedication to his book. □

South American rattlesnake

SR RECOMMENDS

SR of The Sciences *recommends the following five recently published books in the sciences as being, in the judgment of the editors, particularly worthy of attention.*

ALBERT EINSTEIN: Creator and Rebel. By Banesh Hoffman with the collaboration of Helen Dukas (Viking, $8.95)—An informative and readable account of Einstein's life by a colleague who takes the sensible position that to understand the man, one should understand the works.

BLACKBERRY WINTER: My Earlier Years. By Margaret Mead (Morrow, $8.95)—Margaret Mead's story from her birth in 1901 to the outbreak of World War II—Polynesian field trips, three husbands, growing fame, and singular determination.

FREUD: Living and Dying. By Max Schur (International Universities, $20)—The physician who attended Freud during the last ten years of his agonizing illness searches for the key to the interlocking chambers between the young and the adult Freud and succeeds, in this superb biography, in demystifying and humanizing a rich and complex life.

LICIT AND ILLICIT DRUGS. By Edward M. Brecher and the editors of *Consumer Reports* (Little, Brown, $15)—From the Consumers' Union, the compleat drug book—everything from cocaine to caffeine—with recommendations for workable drug laws.

THE SERENGETI LION: A Study of Predator-Prey Relations. By George B. Schaller (Chicago, $12.50)—A major scientific study of the life and behavior of the East African lion and its predator-rivals and prey by a leading zoologist and author of *The Year of the Gorilla* and other books.

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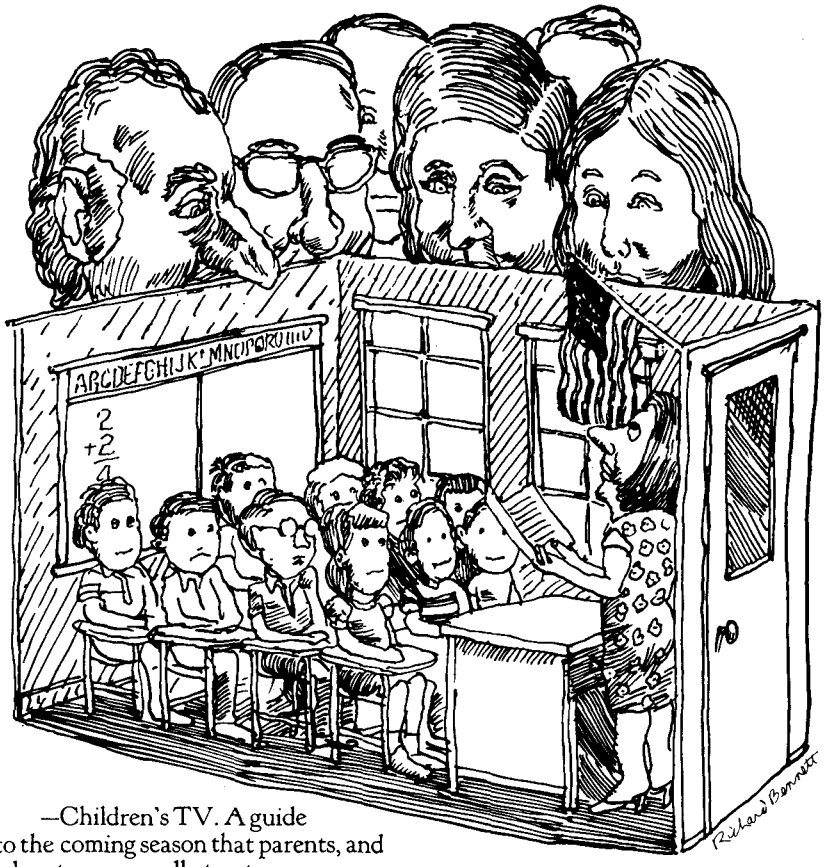

—Children's TV. A guide to the coming season that parents, and educators can really trust.

—The "blue-collar" colleges: as open admissions becomes policy in many colleges, what experience from the past will be significant?

—Do those "crash courses" for the College Boards really help?

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MUSIC

A Weekend Chez Boulez

BY IRVING KOLODIN

Several things emerged clearly from a weekend *chez* Boulez that included three concerts with the New York Philharmonic and the world premiere of his ". . . explosante/fixe . . ." in Alice Tully Hall: first, Pierre Boulez is the first musician of note to endorse the concept of Lincoln Center as a community of the arts by sharing his time at the Philharmonic, of which he is now committed to be music director until 1976, with The Juilliard School and the Chamber Music Society of the complex, which commissioned his newest work; second, his role for electronics in music's future is to aggrandize rather than diminish the function of living, performing musicians; and third, he is energetically pursuing all these objectives.

In his new work for eight instruments, sound-reproducing system, and six speakers, no use is made of tape or prerecording. The title, derived from a phrase of André Breton, can be loosely paraphrased as embodying, in the "explosion" phase, the free contact of one instrument stimulating another, yet "fixed" by perimeters of compositional discipline.

Each instrument is provided with its own microphone for feeding its tone through an apparatus called the Halaphone (after its inventor, Peter Haller). At the option of the console's operator—on this occasion cued by Boulez himself—the sound can be heard pure or tonally transformed through circuits that feed one or all of the speakers positioned around the auditorium. The transformations can be preprogrammed by electronic devices similar to those utilized in presetting the light board of a contemporary theater.

Thus, in brief, the mechanics of ". . . explosante/fixe . . . ." The esthetics are quite another matter. After an expressive, indeed fanciful, phrase for flute (expertly played by Paula Robison), the work progressed through variations, extensions, and elaborations of the phrase that were passed around the members of the group (Charles Treger, violin; Walter Trampler, viola; Lynn Harrell; cello; Gerard Schwarz, trumpet; Michael Webster, clarinet; Gloria Agostini, harp; and Richard Fitz, vibraphone). Sometimes they played alone, sometimes as an ensemble, with options for choosing to enter on their own initiative (indicated by hand signals to the other players).

To what extent the performance of Sunday afternoon (the second of two) coincided with Boulez's intentions, only he could say. The console and control units of the Southwest Germany Radio (Freiburg) were not designed to be portable, and some complications—hum, feedback, etc.—may have been a consequence of the improvised way in which they were brought to New York.

But enough did emerge to persuade me that the line of thought to which Boulez has directed himself has a functional future. It makes the machine not the master of man but his servant. It does not, as so much tape recording does, make the performer merely an extension of an instrument but its living, breathing, creative pulse.

The rest is in the keeping of Boulez, a serious musician and no sensationmonger. No doubt when the first man to devise a pedal for an organ demonstrated his invention, somebody scoffingly said, "Who wants to play music with his feet?" After a couple of centuries the answer was: "Everybody."

The Philharmonic portion of the weekend afforded such varied interests as the Fourth Concerto of Beethoven with André Watts as piano soloist, the C-major (*Linz*) Symphony of Mozart, and the always welcome *Valses nobles et sentimentales* of Ravel. There was also an authentic oddity, the Overture, Scherzo, and Finale by Robert Schumann bypassed by most of the novelty seekers in recent years.

A product of the period during which Schumann produced his beloved *Spring* Symphony, that is, when he was thirty-one and newly married to his much-younger Clara, the tripartite sequence shares many of its qualities of vivacity, freshness, charm, and originality. What undoubtedly has inhibited more frequent performances is the rather amorphous nature of the work. It is neither overture, suite, nor symphony, and thus conforms to no prescribed time period, category, or "slot," in the average symphonic program in this country.

Does this mean Boulez was inhibited from performing it? Obviously not. He merely created a "slot" of his own for it, as a "prelude"—since it is neither overture nor symphony—to the Beethoven G-major Concerto. The results were altogether happy, except with respect to Schumann's oft-admired diligence. One instance in which he failed his admirers was by neglecting to write a slow movement that would have made the work a fifth symphony. (Perhaps he already had a vision of Brahms's writing four symphonies "in the model of his predecessor and idol Robert Schumann" and didn't want to impose one more burden on Brahms.) It was, in any case, rewarding to hear in a cogent, well-balanced, admirably concise performance.

The same words could be applied to the joint effort of Watts and Boulez with the Fourth Concerto of Beethoven as well as a few others, such as "finely formulated," "tightly knit," and "intellectually ardent." For Watts it was a kind of musical coming-of-age, a celebration on behalf of his emergency replacement ten years ago on a Philharmonic program for an indisposed Glenn Gould, and on behalf of the good things that have accrued to him. The best of the good things was the very last: the ability to play so subtle a work as the Beethoven No. 4 with an admirable range of pianistic colors and in a proper sense of musical interplay with the orchestral direction of Boulez.

As Watts has still to celebrate his thirtieth birthday, there remains ample time for him to master the poetry as well as the prose of this work, its evasive depths as well as its accessible surface. The opening solo was exceedingly well conceived, in a beautiful statement of one of the most poetic of all the moments in this inimitable score. But this promise was not always fulfilled in the many similar moments that followed. Nor did he get all the help that he might have from Boulez, whose unfamiliarity with the work's problems was, perhaps, a shade greater than the soloist's.

In a curious inversion of coloristic and quantitative values, Boulez chose to follow the intermission with Ravel's *Valses nobles et sentimentales* and to end the evening with the Mozart symphony. It was luminous Ravel he offered, more *noble* than *sentimentale* but beautifully formulated for maximum orchestral effect. In these circumstances he might have better ended the evening with Haydn's *Farewell* Symphony, to match the gradually diminishing audience with the dwindling number of players prescribed by the composer. □

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FILM

On Saving the Tiger

BY ARTHUR KNIGHT

It is just possible that *Save the Tiger* will turn out to be the most important picture of 1973, as important to the screen as *Death of a Salesman,* which it resembles in many ways, was to the theater back in 1949. Again we are concerned with the moral choices of a man in a world that has changed almost beyond his comprehension. The old values are gone. The new ones, the values by which he must live if he is to survive in business, are repugnant to him. Like Willy Loman, out there "on a smile and a shoeshine," Harry Stoner is neither worn out nor incompetent. More than able and wholly realistic, all he wants from life is "one more season" for his dress company, Capri Casuals—even if it means committing arson to get it.

By the time the film opens, Harry has decided to burn down one of his factories. What we are shown is how that decision affects him as a man. Furthermore, as in *Death of a Salesman,* we are shown the mirror-image of a society gone awry, a society in which human values are twisted and negated by crassly materialistic concerns. The main difference is that in *Save the Tiger,* coming a quarter of a century after *Death of a Salesman,* the society has grown considerably more rotten.

Steve Shagan, who wrote and produced the film, is one of the tough-minded new breed of Hollywood filmmakers. Now in his early forties, he has worked in just about every phase of the business—as grip and electrician, as studio publicist, as TV producer on the old *Tarzan* series, and as producer-writer on several *Movies of the Week.* He learned about movies the hard way, and the process has made him more than a little chary of people, whether in films or out. There is about him an idealism that he is reluctant either to admit or to relinquish, but that shows through clearly in every line of his script. Like Harry Stoner, Steve Shagan longs for the old days when issues were clearer—when you fought a war and knew what you were fighting for, when you could vote and know what you were voting for, when the United States flag was a sacred symbol and not somebody's jockstrap or bikini. But Shagan also realizes that those days are gone, and out of his sense of loss and his pragmatic sense of the realities of today, he has fashioned his steely yet compassionate screenplay.

Harry, with his Beverly Hills home, his daughter in a Swiss college, his Lincoln Continental complete with mobile telephone, figures it costs him "$200 just to get out of bed in the morning." While Shagan holds no brief for this way of life, neither does he condemn Harry for living it. Shagan can see, with ironic clarity, that it is this standard of living that has brought Harry Stoner to his dilemma. The money that Harry and his partner, Phil, siphon off from their business is the money that they need to finance the next season's line. Harry may protest about taxes, the unions, the banks, and the gangsters, who all want to slice into his profit margin, but it would never occur to him to reduce his scale of living—even though it produces for him precious little in terms of happiness or personal gratification. Instead, he longs for the past—the old songs, the old bands, the old ballplayers, his dead friends at Anzio. He makes a final gesture at the end of the picture—an old-fashioned wind-up and pitch that sails the ball way over the heads of the kids playing sand-lot baseball. "Why'd ya do that, mister?" one of the kids whines. "I thought you ought to see it just once," Harry replies. There aren't too many of these old tigers around, the guys who remember it like it was. For all of their faults, Shagan tells us, they might be worth saving. And when the chief tiger is played by Jack Lemmon, it is a contention difficult to deny.

In contrast to his strained and overaccented portrayal of an American businessman in Billy Wilder's *Avanti!* (made after this one), in *Tiger* Lemmon is always right as Harry. He begins his day with a properly dyspeptic stomach, is properly incredulous when he listens to the proposition of a fresh-faced Sunset Strip hippie, properly put off by the calculated put-down of the black who parks his car. Harry Stoner goes through twenty-four hours of accelerating tension, and at each point Lemmon lets us see not only the toll of those tensions but the basically decent guy underneath, the one we are sympathizing with and rooting for. In one of the film's final sequences, sharing a beach pad with the teen-ager he had met earlier that same day, Harry launches into a litany of all the famous names that are meaningful to him. At that moment all role playing ceases. Harry Stoner and Jack Lemmon are as fused as any actor ever can be with the character he is creating.

No doubt director John Avildson had a good deal to do with this. As in his earlier *Joe,* he seems to have a special facility for just letting his actors *be* and making what they do just seem to happen. The actors have caught Shagan's characters and made them their own (or perhaps vice versa; in either case it works marvelously well). No less remarkable is Avildson's ability (with a notable assist from his cameraman, James Crabe) to impart a sense of verisimilitude to places, be they a Beverly Hills mansion, a factory in the forlorn garment district of downtown Los Angeles, one of L.A.'s swankier downtown hotels, a restaurant in Chinatown, or a clandestine meeting place in the balcony of one of the city's innumerable porno palaces. The effect is always documentary, of a reality discovered rather than arranged. Considering that the film was produced entirely in Los Angeles, the fact that not one foot originated in a studio almost speaks for itself.

But beyond any technical considerations, the real virtue of this essentially modest movie is that, in effect, it bridges the generation gap. Many of the older generation will recognize themselves in it and will weep because they have no better solution to Harry Stoner's dilemma than does Harry himself. And a still younger generation, with any compassion at all, can see in Harry their own fathers making unwilling compromises with a world, and a system of values, that they detest as much as their sons do. One can't wholly admire Harry Stoner, but if we can at least feel for him, then we have some sense of where, how, and why our whole world today seems out of joint. And, cursed spite, the Harry Stoners will never set it right. They are at once too involved and too vulnerable. *Save the Tiger* offers no easy answers to today's social malaise, but it poses all the right questions—and that in itself is not only an admirable feat but a long step in the direction of a meaningful solution. □

Answer to Wit Twister, page 73: rulest, lurest, luster, rustle, result, sutler, ulster.

Answer to Literary Crypt No. 1539
We are told by moralists with the plainest faces that immorality will spoil our looks.
L. P. Smith

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KINGSLEY DOUBLE-CROSTIC

Reg. U.S. Patent Office

By Janet Elliott Cameron

No. 2024

DEFINITIONS

A. Conceited

B. Hard to please

C. Express with abandon (3 Wds.)

D. Ambition

E. Enterprising fellow (slang)

F. Overload

G. Barrier filling the southern part of the Ross Sea (3 wds.)

H. Annuity scheme in which survivors share a common fund with the benefit of survivorship

I. Song popular with the American troops during the Revolutionary War (2 wds.)

J. Beforehand (2 wds.)

K. Directly from the horse's mouth (3 wds.)

L. Three Jewish divisions of the Pentateuch or Torah taken as a whole

M. One-time rotund character actor who usually played an underworld boss or a bad guy in general (2 wds.)

WORDS

141 60 52 92 196 98 132 72 176 215 19

112 86 68 5 138 53 146 211 17 103

158 61 6 145 104 54 214 18 97

13 102 150 21 51 73 113 193 170 142

55 147 63 8 129 229 134

133 64 140 175 231 192 56 230

153 20 114 139 7 234 101 149 203 159 87 167

115 16 57 62 197 14 232

235 2 169 9 173 222 15 200 100 69 212 226

10 22 65 213 3 88 208 58 202

59 219 228 66 116 155 143 135 168 11 89

137 31 205 152 1 199

4 12 71 136 95 99 144 227 201 117 67 206

DEFINITIONS

N. Type of feline (2 wds.)

O. Easy (slang; 2 wds.)

P. Fade away

Q. Outmoded piece of furniture

R. Portion of the Prophets that is chanted or read in the synagogue on the Sabbath

S. Russian dramatist, among whose best-known works is *The Storm*

T. Hopeless pursuit (2 wds.)

U. Balance

V. Largest ancient region of Greece

W. Quickly prepared dish of flour or oatmeal stirred into salted boiling water; Harvard Club (2 wds.)

X. Scholarly introduction to a field of study or research

Y. Any of several rare flightless gallinulelike birds of New Zealand

Z. Simpleton

WORDS

49 39 124 171 157 74 180 220

163 204 40 110 93 122 75 105 48

28 90 207 76 50 161 35 111

24 94 154 221 80 156 123 187 41

225 164 45 198 183 79 190 25

125 34 162 32 223 77 42 118 106

131 36 172 107 46 30 218 181 78

47 174 148 33 37 127 191 233 81 224 91

82 108 119 182 188 151 44 96

210 109 184 165 126 29 178 209 38 83 194 23

186 128 120 130 84 216 43

121 166 189 217 27 85 160 179

195 70 177 185 26

DIRECTIONS

Don't let the definitions scare you. If you can guess five or six of these WORDS correctly, you should be able to solve the Double-Crostic . . . . When you've guessed a WORD, fill in the dashes, and also write each letter in its correspondingly numbered square in the diagram. When all the squares are filled in, you will have a quotation from a published work. Dark squares indicate the ends of words. If there is no dark square at the right side of the diagram, the word carries over to the next line . . . . You should be able to see words and phrases begin to form in the diagram on the basis of having just a few letters. Enter the letters you can guess into the diagram and the blanks in the defined WORDS, and you'll find yourself working from WORDS to diagram and back, solving the puzzle. . . . The initial letters of the defined WORDS spell the name of the author and the title of the work from which the quotation was taken. This acrostic feature can be very helpful to the solver.

	1 L	2 I	3 J	4 M	5 B	6 C		7 G	8 E		9 I	10 J	11 K	12 M		13 D	14 H
15 I		16 H	17 B	18 C	19 A	20 G	21 D	22 J	23 W		24 Q	25 R	26 Z	27 Y	28 P		29 W
30 T	31 L	32 S		33 U	34 S		35 P	36 T	37 U	38 W		39 N	40 O	41 Q		42 S	43 X
44 V	45 R	—	46 T	47 U	48 O	49 N	50 P	51 D	52 A	53 B		54 C	55 E	56 F	57 H		58 J
59 K	60 A	61 C	62 H	63 E		64 F	65 J	66 K	67 M	68 B		69 I	70 Z	71 M	72 A		73 D
	74 N	75 O	76 P	77 S	78 T	79 R	80 Q	81 U	82 V	83 W	84 X	85 Y	86 B	87 G		88 J	89 K
90 P	91 U	92 A	93 O	94 Q	95 M	96 V		97 C	98 A		99 M	100 I	101 G	102 D		103 B	104 C
	105 O	106 S	107 T	108 V		109 W		110 O	111 P	112 B	113 D		114 G	115 H	116 K	117 M	118 S
119 V		120 X	121 Y	122 O		123 Q		124 N	125 S	126 W	127 U	128 X	129 E		130 X	131 T	132 A
133 F		134 E	135 K	136 M	137 L		138 B	139 G		140 F	141 A	142 D	143 K	144 M	145 C	146 B	147 E
148 U	149 G		150 D	151 V	152 L	153 G	154 Q		155 K	156 Q	157 N	158 C	159 G		160 Y	161 P	
162 S	163 O	164 R	165 W		166 Y	167 G		168 K	169 I		170 D	171 N	172 T	173 I	174 U	175 F	176 A
177 Z	178 W	179 Y		180 N	181 T	182 V	183 R	184 W	185 Z	186 X	187 Q		188 V	189 Y	190 R	191 U	192 F
193 D	194 W	195 Z		196 A	197 H	198 R	199 L		200 I	201 M	202 J		203 G	204 O	205 L	206 M	
207 P	208 J	209 W		210 W	211 B	212 I	213 J	214 C	215 A	216 X		217 Y	218 T	219 K		220 N	221 Q
222 I		223 S	224 U	225 R	226 I	227 M		228 K	229 E	230 F		231 F	232 H	233 U	234 G	235 I	

Solution of this issue's Double-Crostic will be found on page 20.

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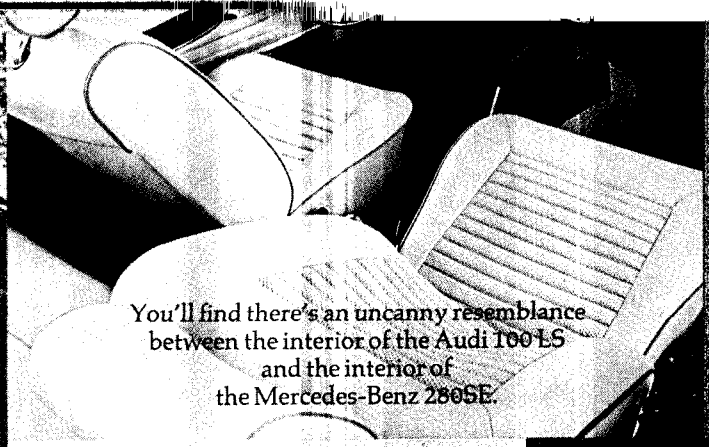
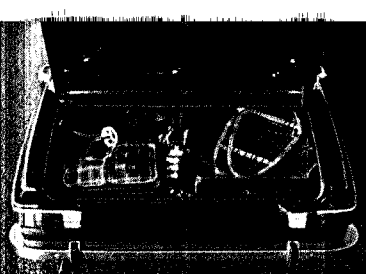
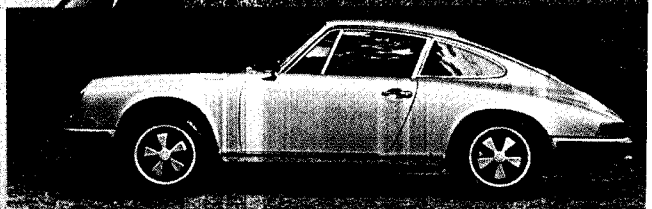
The simplest, most direct steering system — rack-and-pinion steering. The 512 racing Ferrari has it. So does the Audi.



You'll find there's an uncanny resemblance between the interior of the Audi 100 LS and the interior of the Mercedes-Benz 280SE.

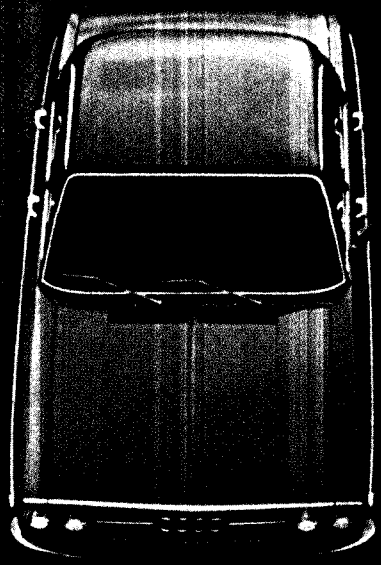


The Audi has the same amount of trunk space as the Lincoln Continental Mark IV. In fact, a little more.



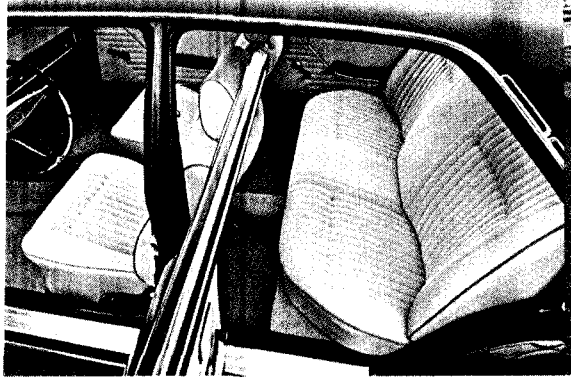
We've got the same type of dependable ignition system as the Porsche 911.

Both the Cadillac Eldorado and the Audi have front-wheel drive. But we had it first.



The Aston Martin has independent front suspension. So does the Audi.

Don't let the size of the Audi on the outside fool you about the size on the inside. It has just about the same headroom and legroom as the Rolls-Royce Silver Shadow.



The Audi gets the same expert service as a Volkswagen. Because it's part of the VW organization.

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